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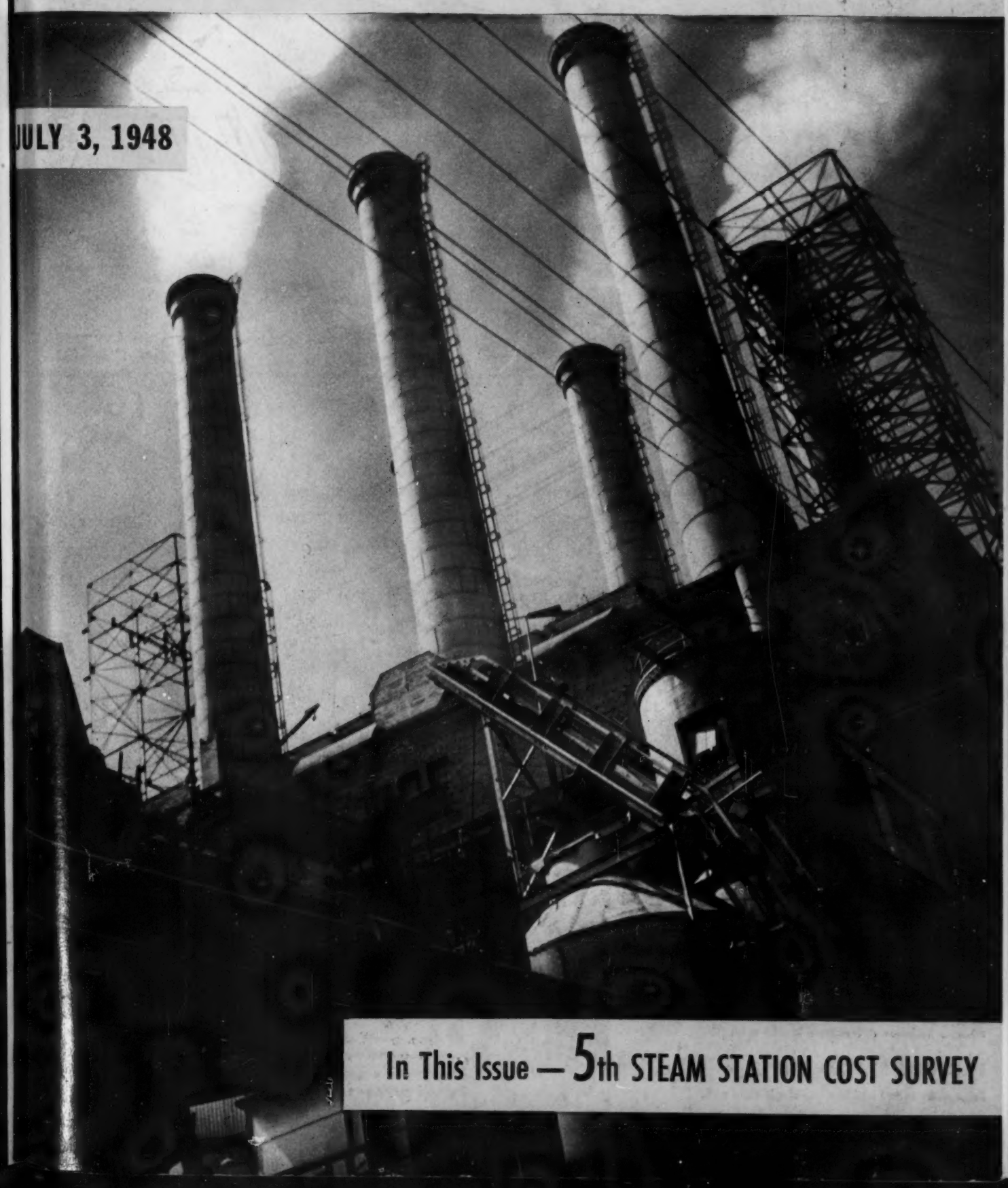
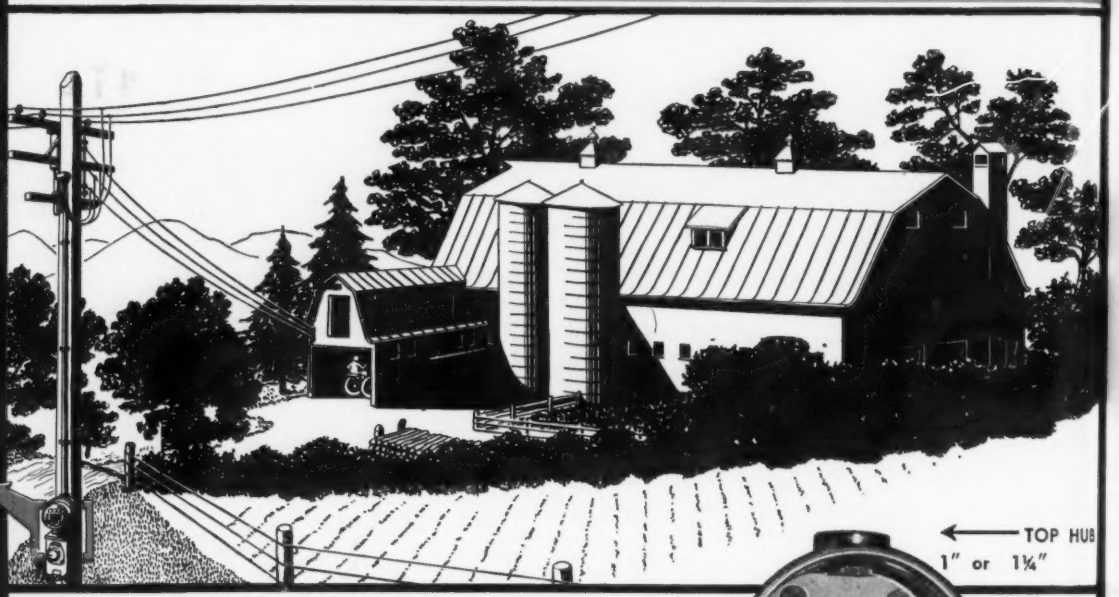
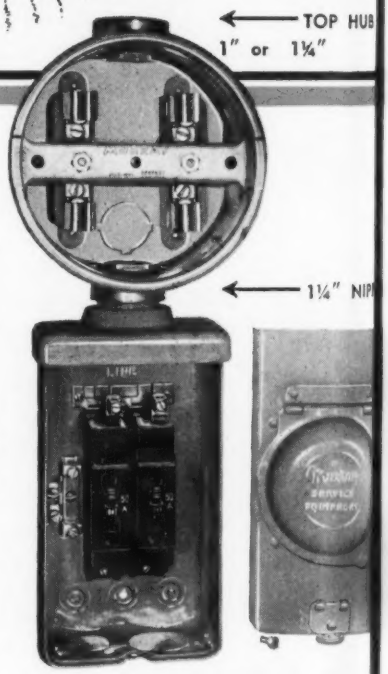


JULY 3, 1948

In This Issue — 5th STEAM STATION COST SURVEY

NEW— Murray COMBINATION to CUT INSTALLATION COST!





Cat. Nos. 1962-35 or 1962-50

This new Murray Combined meter socket and yard pole breaker box answers the many requests for just such a labor and cost saving device.

The combination is staked at the factory, thereby eliminating the usual need for assembly and alignment. Installation on poles or walls is quick and simple.

A glance at the "High Spots" listed at the bottom, shows a few of the good reasons why it will be to your advantage to install the NEW Murray Combination Socket and Murray Magnetic Circuit Breaker Service Equipment.

SEND FOR BULLETIN No. 504

APPROVED BY REA

HIGH SPOTS

METER SOCKET

Deep-drawn aluminum case with integral weatherproof lip.

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Reversible jaws, quickly adjustable for vertical or horizontal meter mounting.

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ELECTRICAL WORLD

Published for 74 years for those engaged in the business of generating, transmitting, distributing or applying electric power

July 3, 1948 — Vol. 129 No. 27

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Marking the appearance of the 5th Steam Station Cost Survey, this photo, taken by EW's Art Editor, Earl Carver, symbolizes the expansion of activity that has taken place in the industry since the last survey appeared in 1939

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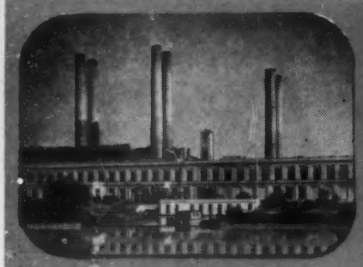
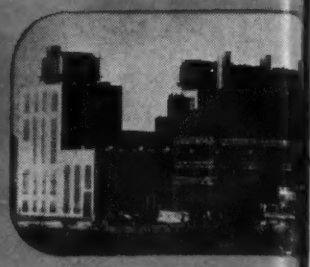
COMING IN JULY 17 ISSUE

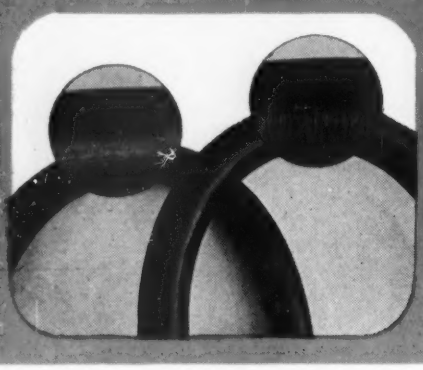
Modern Transformers Are Money Savers
Petersen Coil Tuning Determines Performance
Meters Shop-Tested And Reconditioned in 33 Minutes

OKOLITE-OKOPRENE CABLES ARE INSTALLED





WHY STATIONS HAVE STANDARDIZED ON



Thirteen years exposure in Okonite's outdoor proving ground clearly shows that Okoprene sheaths are unimpaired while rubber coverings "check" and deteriorate.

The effects of atmospheric exposure in contributing to cable deterioration are studied in this test cell developed by the Bell Laboratories.

LOW COST INSTALLATION AND OPERATION

The complete simplicity of Okolite-Okoprene cables reduces weights and handling problems to a minimum and eliminates corrosion and electrolysis since no lead sheath is required. Splicing and terminating methods are also greatly simplified as potheads, lead sleeves and filling compounds are unnecessary.

PROPERTIES	LOCATIONS	OKOLITE-OKOPRENE PROPERTIES
LONG LIFE AND RELIABILITY	All electrical circuits.	Confirming nearly a quarter-century of field experience, continuous aging tests of Okolite insulation checked at intervals in Okonite's proving ground, show practically no change in physical and electrical characteristics. Okolite oil-base insulation, applied by Okonite's strip process, is made with wild Up-river Fine Para rubber established over many years of steady use as stable and dependable. Exposure tests and service records over 13 years have proved the durability of Okoprene coverings.
ELECTRICAL STABILITY	All control, power, lighting, and switchboard circuits.	Electrical measurements made on Okolite insulation after 8 years immersion in water show the insulation resistance unchanged from the excellent values recorded in the first 6 months. Insulations made with synthetic rubbers show no such stability. Retention of Okolite's stable electrical qualities is further insured by the Okoprene sheath that seals the insulation from terminal to terminal.
HIGH DIELECTRIC STRENGTH AND OZONE RESISTANCE	Generator and transformer leads, auxiliary power circuits, test cables, etc.	Okolite's high dielectric strength is greatly increased by the use of Semicon tape over conductors operating above 2000 volts. Therefore, in addition to a-c. tests at voltages 25% greater than IPCEA requirements, all such Okolite-Okoprene cables are also given a self-imposed d-c. kenetron test at 3 to 4 times the IPCEA 60-cycle a-c. values. Internal and external ozone attack is resisted in 4 ways: (1) Okolite insulation is ozone-resistant, (2) Semicon tape prevents internal corona discharge, (3) Okoprene covering is not only ozone-resistant but (4) does not develop static discharge below 5000 volts.
MOISTURE RESISTANCE	Cables in ducts, troughs, or buried direct and wherever condensation exists.	Okolite insulation—*without any lead covering*—has been used for 20 years in submarine power cables, some of which operate at 35,000 volts. From its Okoprene sheath that cannot rot to its conductor coated with Okoloy — the lead alloy that outlasts tinning 2 to 1 — an Okolite-Okoprene cable resists attack by moisture.
HEAT AND FLAME RESISTANCE	Boiler rooms, tunnels, and other hot locations and for heavily-loaded cables.	Okolite insulation, recommended for use at 75 degrees C up to 8000 volts and 70 degrees C above 8000 volts, is suitable for heavy current loadings or for hot locations. Since equally heat-resistant Okoprene coverings will not support combustion, Okolite-Okoprene cables are also non-flammable, a feature of prime importance in station design.

ELECTRICAL WORLD — Editorials

JULY 3, 1948

Platforms and Power

THE PLATFORM adopted at Philadelphia last week by the Republican party has interest for the power business. This is particularly true if that which was adopted is compared with that which was presented to the resolutions committee. The GOP platform makes these promises:

1—The party favors "comprehensive reclamation" which fully protects states ". . . in the use and control of water for irrigation, power development incidental thereto and . . ."

2—The party favors "progressive development of the nation's water resources for navigation, flood control and power, with immediate action in critical areas."

3—The party favors private enterprise in air transport, the merchant marine, communications and housing. If it also favors private ownership of power, it does not say so.

The reclamation plank is interesting because the original draft spoke of "power development," not of "power development incidental" to irrigation. There's a difference which is big enough to mean a great deal, but which also is small enough to be lost quite readily. If "power development incidental" to irrigation were practiced by a Congress which meant just that, there could be an end to the type of activity for which the Reclamation Bureau has drawn increasing criticism during the last five years. Under such rules, the Central Valleys and the Columbia Basins would put water on the land as well as kilowatts in the hills. But revaluing today's emphasis on power would have to be seen to be believed.

The plank on water resource development also is interesting because of changes from the original draft. Originally, it was "progressive development, with adequate appropriations, of the nation's water power resources . . ." etc. And there certainly is a difference between the two planks—as we see it, not a good one.

As we've said before, ELECTRICAL WORLD thinks the government ought to get out of the power business and stay out. But if it's going to remain in the business, then Congress must grow to a point at which it can recognize its job and do it. That job is to decide thoughtfully whether, in fact, it wants to assume responsibility for area power supply here and there; then, if it does assume responsibility, to meet it with the necessary funds—on time and in plenty. In the Pacific Northwest, Congress has taken this first step but failed miserably on the second. And the Pacific Northwest is in trouble as a result.

It may be that the Republican administration which seems in prospect for the next four years will take a long look at the non-political aspects of power supply and then, with a thorough grasp of it, conscientiously work out the political problems attendant on it. Were it to do this, the party would be making sense far beyond any power plank of any party platform in years.

In the absence of such calculated federal policy in power, one may only anticipate piecemeal expansion, determined by political rather than economic motives. Ultimately, such haphazard expansion would bring the troubles facing the Pacific Northwest today to other regions. Who would risk this deliberately?

Where We Stand and Why

". . . THE MOST IMPORTANT job facing businessmen today, and the greatest opportunity they have to serve their own interests, as well as those of the nation, lies in:

"Recognizing the threat to human freedom in today's political, social and economic trends.

"Understanding the nature, causes and cures of this threat.

"Realizing the ultimate consequences to themselves, their companies and their nation if present trends are unchecked; and

"Doing something effective about it . . .

"I believe it to be the Number One responsibility of the business press to supply such help. It is no longer sufficient for the business press merely to provide the technical and vocational help that already has been developed to such a high degree of effectiveness. What business needs in addition is knowledge and courage to do the broader and the vastly more important job that I have just outlined.

"Preserving human freedom cannot be done by merely insisting upon enjoyment of inalienable rights without, at the same time, living up to the many and often painful responsibilities which these rights entail. If these rights are to be preserved at all, they must all be preserved. Destroy one and the others are in jeopardy, for the reason that the destruction of any one of them destroys the philosophical basis of all the others and the door is then open to slavery in one or more of its modern forms.

"Today that inalienable human right which is most vulnerable to attack and which is being most vigorously and successfully attacked is the right of property . . . upon the outcome of this struggle over property rights depends the survival of all our other inalienable rights because, it must never be forgotten, the right of property is a human right. So, no matter how much or how little property a person has, it is desperately in his interest to defend the right of property if he wishes to remain free."

These words were addressed recently to ELECTRICAL WORLD's staff. They were spoken not by a business publisher, but by a utility man, H. H. Dinkins, Jr, of the Electric Bond and Share Co. They are perfectly true, and re-inspiring words. Humanly enough, we all have become preoccupied with day-to-day concerns, to the exclusion of age-to-age principles. We think the entire power industry, from the Congressional directors and the lay directors on down, had best act on them while there is still time.

Television Voltage

TELEVISION SETS in general perform satisfactorily from 105 to 125 volts, an ideal range from the power company standpoint under normal operating conditions. But currently, necessary voltage reductions shrink the image size. So some television manufacturers are campaigning to have voltage in homes held to as low as a 2.5 percent variation. They ignore the fact that progressively superior voltage regulation on distribution systems costs progressively more dollars. Voltage regulation economics already have been threshed out in connection with the permissible variations allowed by state regulatory authorities.

Rather than expect the power companies to meet utterly impracticable voltage uniformity, the television producers should provide means for voltage regulation within the sets. This entails an outlay only a very small fraction that the power company would have to make—all over the system. Automatic volume control was a big asset to AM radio; its counterpart should be a component of FM radio and video, at least in the more expensive sets.

Incorporation of such automatic correction would enhance the performance of television sets and avert unwarranted complaints to either the utility or the set manufacturer.

No-Rate-Base-No-Rate-of-Return-No-Good

WE ASKED a Wisconsin Public Service Commission official, months ago, on what basis a court could review the reasonableness of the profit WPSC had just allowed the Commonwealth Telephone Co for service in Two Rivers, Wis. Our question came, naturally enough, in connection with that unusual rate order the Commission had just rendered in the Two Rivers case. The order, one recalls, held that a regulatory commission need not value a utility's property nor establish a rate of return on any such valuation. It was enough, WPSC ruled, to estimate a "reasonable" profit which a utility might enjoy from a given operation. This incidentally, became known as the "no-rate-base-no-rate-of-return" order.

The answer to our question about how a court could possibly review such a finding was simple enough. We were told that everything on which the Commission based its action was to be found in the record. If a jurist wanted it, he could find it there, the man said. And we recall wondering whether this WPSC man wasn't attributing to the Wisconsin judiciary a good deal more energy than we'd require of anyone.

Wisconsin's Supreme Court answered the question the other day. It found against the PSC and upheld a lower court order which had reversed the PSC stand. The high court asked: "How can the Commission or the reviewing court or the utility or the public determine whether the profit is proper unless the Commission makes specific findings of the 'relevant facts and circumstances'?"

It would have been interesting to know whether the high court couldn't find what it needed in the record, or whether it didn't bother to look. But whatever the energy of Wisconsin's judiciary, its diligence is commendable. Without impugning WPSC's motives in the least, its concept of a "new look" in rate regulation was a little too free. For everyone concerned, it's a good thing the courts spiked it.

NEWS OF THE ELECTRICAL WORLD

The Electrical Week

Tom Dewey, Republican candidate for the Presidency, has had little opportunity to establish a record on electric power issues. Judging by his speeches, he favors development of public power, but only to supplement private power. He opposes valley authorities. . . . July 15, ELECTRICAL WORLD gets a new editor. He is Fischer S. Black, now assistant to the president of PEPCO. . . . Wage increases won by the coal miners are going to have repercussions in the electric utility industry. A survey shows some utilities will be forced to seek additional revenue. No broad move to raise rates is indicated. . . . In Mexico City, AIEE promoted international amity with its summer general meeting. The Mexican government gave the Americans a cordial reception. EE's north and south of the border gained a better understanding of each other's problems.

TVA's proposed steam plant at New Johnsonville, Tenn., phoenix-like, already is reviving from the ashes of its recent defeat in Congress. Washington talk has funds for the plant included in the federal budget for fiscal 1950. The new budget, now being prepared by the present administration, will go to Congress before inauguration day, January 20, 1949.

Several Republican Congressmen are unhappy over the ouster of Reclamation Commissioner Mike Straus contained in the 1949 Interior Appropriations Bill. It forces Straus' departure by January 31 by forbidding salary payments after that date to any Reclamation Commissioner who, like Straus, is not an engineer. On the other hand, it requires appointment of an engineer to replace Straus. Some GOP leaders have candidates for the job who are not engineers.

SEC estimates show that individuals, as a group, increased their holdings of currency, bank deposits, savings and loan shares, insurance and pension reserves and U. S. government securities by more than $14 billion last year. At the same time, they increased their holdings of corporate, state and local government securities by only $1.5 billion.

Eastern Europe's Communist editors are burning about being "scooped" by the capitalist press on the Tito story. They've always said the capitalist press was decadent. No doubt they'll use this to prove it.

One company has proposed that holders of its junior securities subscribe the funds needed to retire some senior obligations. Then the junior holders may share any dividends which are paid. This sounds like not eating your cake so you may have it.

Sign-Of-The-Times Dept.? PSCo of New Hampshire has withdrawn an application to SEC for approval of $5,200,000 in bank loans. They aren't needed after the sale of 139,000 shares of common stock.

Even isolated plants are expanding to meet load growth. The University of Illinois plant is getting a new boiler and generator, upping capacity 3,000 kw. Five new buildings and two major additions will be opened within the next year, to load the enlarged power plant.

You'll get word any day now as to which, if any, of your employees between the ages of 19 and 25 will be exempted from the new draft. Selective Service officials are working out with National Security Resources Board and other advisory groups a list of "critical" personnel. Industry will be advised of the exemption standards by local draft boards. First draft is expected late in August or early September.

Oh-What-a-Beautiful-Morning-Dept: British Columbia Power Corp's Bridge River development is 9 months ahead of schedule. Three 62,000 hp units are supposed to be completed this year.

Discount the talk coming from public power sources in South Carolina to the effect that a transmission network, financed by REA funds, is to be built from the Santee-Cooper power project. The talk is mostly political. REA won't make the loan—at least, not in the near future.

Dewey's Stand on Power Issues Must Be Garnered from Speeches

As GOVERNOR of New York, Thomas E. Dewey established little that might be termed a "record" on electric power issues. With one notable exception, he simply had no opportunity to deal officially with matters of broad ownership significance to the utility industry.

But as a candidate for the Republican presidential nomination—before he won it at Philadelphia last week—he had a lot to say about key political issues of concern to the utilities.

On several of these matters, Dewey expressed very definite views in a series of speeches during the last few months in the Pacific Northwest, Nebraska, Wisconsin, and elsewhere. While no candidate can finally commit himself or his party so far in advance of election, Dewey indicated that he already had formed at least a working basis for a possible Republican administration power policy. How much these views might be influenced between now and the election by his running mate, California's power-minded Gov Earl Warren, or other considerations, cannot be estimated.

Candidate Dewey's speeches were especially definitive on the subject of development of hydroelectric power in conjunction with harnessing river resources. In talks in Oregon and Nebraska, he specifically recommended:

1: That the hydro generating potential of our streams be fully developed—and quickly.

2. That, in the case of major streams, at least, the federal government must build big multiple-purpose projects required for full utilization of river resources.

Contrary to some interpretations, the Dewey speeches gave little or no encouragement to proposed extension of the valley authority method of river development. For example, he singled out in a speech at Holdredge, Neb., on April 8, the proposed Missouri Valley Authority as an "absurd" plan to put "the interests of 10 states" under control of three federal officials.

Perhaps the most significant statement in Dewey's score of pre-Philadelphia speeches came, May 1, at Portland, Ore. There he gave strong indication of his views as to just how far the government should go into the utility business.

"Our water developments are of such size and scope that they are by their nature public works," he pointed out. "They should supplement and support, rather than supplant, the private enterprise on which we can rely to carry us into a new expansive era of progress and well-being."

In the same address he called for river development on "a regional basis." Large-scale projects planned for the drainage basins of the "Missouri, the Columbia nad the Willamette," he asserted, "are a natural responsibility for the federal government." He specifically urged "aggresive and continued development" of the McNary, Foster Creek, Hungry Horse and Willamette River projects. But he did not once suggest they be completed by a Columbia Valley Authority, though his remarks were so interpreted in some quarters.

Familiar with Power Problems

Throughout the series of pre-nomination speeches, Dewey showed a general familiarity with the nation's electric power problems. At Portland, again, he discussed power supply generally in the following terms:

"Through all the country, reserve capacity is being pushed to the limit, and in some states there simply isn't the power available for the industrial expansion we want."

He advocated full development of federal hydro sites to "supplement and support" private enterprise plans for expanding power capacity. Great as these federal projects are, he added, "they represent but a small part of the capital investment we must have for new plant and equipment in this country."

In his one official action on a power issue of more than state-wide import, Governor Dewey consistently fought for development of the hydroelectric resources of the St. Lawrence River. Last April, after the Senate rejected a new proposal to authorize construction by the U. S. and Canada of the St. Lawrence seaway and power project, he initiated a move for non-federal construction of the power features.

Pushed St. Lawrence Program

The Dewey proposal was that New York and Ontario should build the power plant. He instituted proceedings to obtain approval of the U. S. and Canadian governments under existing treaties between the two countries.

But he put the same qualification upon construction of the St. Lawrence power project that he apparently would impose upon all river developments. The project must be self-sustaining, he declared. He outlined these views at Corvallis, Ore., May 4.

"Hydroelectric power and irrigation are clearly essential for the healthy growth of the Pacific Northwest, and I urge that they go forward to the full extent that they can be honestly self-sustaining and self-liquidating. On this

WHEN TVA SOLD NORRIS, TENN., to Henry D. Epstein, 27-year-old Philadelphia real estate dealer, for $2,107,500, most of the 1,250 TVA employee-residents of the town attended the auction. They had submitted a collective bid of $1,900,000. Epstein promised to give residents a chance to buy their own homes. The town was built in 1933

basis, public appropriations are to be regarded as investments in America's productive future. The same is true of needed flood control and navigation projects."

In addition, the Dewey plan for St. Lawrence power development definitely excluded construction of state-owned transmission lines. Project energy would be sold at bus to private utilities. This recalls a Dewey press statement, issued in the Pacific Northwest in 1944, when he was also the Republican presidential nominee. According to newspaper reports, he told reporters at the time he favored bus bar sale at all federal power developments.

•

Gen Wheeler to Remain as Chief of Engineers

The Army Engineers have decided not to change administrative direction in the face of a likely shift in political winds. Though the Army would not admit it, Lt Gen Raymond A. Wheeler's withdrawal of his application for retirement as Chief of the Corps of Engineers this week (June 28) appeared influenced, at least in part, by political considerations.

The Army announced in mid-May that General Wheeler, 63, would be relieved as Chief of Engineers on June 30. This week it was announced that Wheeler would stay on the job for another year at the request of Army Secretary Royall.

General Wheeler pointed out that he would attain the compulsory retirement age of 64 during the coming fiscal year. During that period, he added, he would direct the largest construction program ever approved by Congress for the Engineers.

There was some speculation in Army quarters also as to the possible effects of the forthcoming draft on the Corps. The Engineers, like other major branches of the Army, is expected to be expanded through the induction of draftees, posing a difficult training problem.

General Wheeler, a West Pointer, has a 41-year record of service in the Engineers, including overseas duty in both World Wars. He was appointed Chief of Engineers on Oct. 1, 1945.

•

Votes Bond Issue for Plant

Officials of Henderson, Ky, have voted a $450,000 bond issue to finance purchase of electrical generating equipment and to build emergency power facilities. The bonds will be paid off from power plant revenues.

Fischer S. Black Appointed Editor of Electrical World, Was with PEPCO

FISCHER S. BLACK will become editor of ELECTRICAL WORLD, July 15.

Black, now assistant to the president of Potomac Electric Power Co, Washington, D. C., will replace Acting Editor George C. Tenney, who has served since Oct 1. Tenney will continue his other duties as president of the McGraw-Hill Co of California, vice-president of the McGraw-Hill Publishing Co, and editor and publisher of *Electrical West*.

FISCHER S. BLACK

Black brings 15 years experience in the operating electric utility business to ELECTRICAL WORLD. It was acquired in the engineering, system planning, and executive departments of PEPCO and the Nantahala Power & Light Co. In addition, he brings an unusual educational background—that of a graduate in both engineering and law.

A native of Bryson City, N. C., Black entered the University of North Carolina, whence he was graduated in 1933 with a BS in Electrical Engineering.

From 1936 to 1939, while employed by PEPCO, he attended the National University Law School, where he won LLB and Master of Patent Law degrees. In addition, he took graduate work in public utility law. During high school and college years, he worked for the Tide Water and Tallahassee Power Cos.

On his graduation from college, Black joined the Nantahala Power & Light Co at Bryson City. There his service included that of a student operator of a hydroelectric plant, substation construction, distribution system maintenance, and appliance selling. On joining PEPCO in March, 1934, Black was assigned first to the dc-ac changeover department as a cadet engineer.

Later, he became a junior engineer, where his duties included cost and efficiency analyses of steam plants, economic and engineering studies of primary and secondary networks and transmission facilities, and preparing and editing manuals and reports.

In 1942, Black became assistant system planning engineer. Special assignments on this job included economic studies of the dc-ac changeover in downtown Washington, studies of primary network distribution, studies of economics of generating plant, additions and electrical characteristics of equipment, and postwar planning studies.

Active in Community Matters

In January, 1946, he became assistant to President A. G. Neal. In this connection, he has represented PEPCO with civic and business organizations, written articles, and participated in public speaking and radio and television interviews, on both company and community matters.

In addition to his professional duties, Black has participated in other activities. In 1942-43, he was an instructor in electrical engineering for the University of Virginia's Engineering, Science and Management War Training Extension Course. From 1940 to 1943, he was an instructor in electrical engineering and college algebra at night classes of the Columbia Technological Institute, in Washington. He has, since 1946, been a director of the Electric Institute of Washington. During the war, he was a War Manpower Commission consultant.

Held AIEE Offices

In college, he was chairman of the student section, AIEE. Continuing active in the Institute, he was chairman of its Washington Section, in 1946-47. A member of the Washington Society of Engineers, he is AIEE representative to the District of Columbia Council of Engineering and Architectural Societies.

From 1943 to 1946, Black worked with the Washington Board of Trade's Postwar Planning Committee and Committee for Economic Development. In 1946-47, he was chairman of the Board of Trade's City Planning Committee. He is a registered engineer in Virginia. Black is married and the father of 3 children.

DAVIS DAM SITE as it appeared last week before the diversion of the Colorado River started. Draglines were used to remove the temporary earth plugs. Then rock and earth were dumped through the upper trestle to form a cofferdam. The river is now flowing around the damsite. The lower cofferdam was erected to keep the river from backing up. At the far end of channel are spillway and power plant under construction. Concrete is being placed on a three-shift, 6-day basis to speed the work.

Hoffman OK's First ECA Industrial Goods

ECA Boss Paul Hoffman gave the green light recently (June 18) for first shipments of industrial machinery and equipment to Europe. As part of a record weekly authorization of more than $215,000,000, Hoffman okayed the shipment of $6,030,000 of industrial equipment to France and Greece.

This marks the real beginning of the reconstruction side of ECA's operations. So far, buying has been confined almost entirely to relief-type goods such as food, fuel and fertilizer.

Volume shipments of machinery and equipment, however, won't be seen until the fall. Chief reason for this is that the various country programs covering industrial buying are still in the making. At the earliest, release of these programs isn't expected until early July. Big shipments are ticketed for the latter part of the third quarter.

Among industrial goods called for in the latest authorization are agricultural, electrical, mining, and other industrial equipment. This includes motor-driven combines, turbines, radiators, electric shovels, tamping rollers, spare parts for machinery, 2-wheeled tractors and dump wagons, rail equipment, and tractor and motor vehicle tires.

About half of the $6-million odd of industrial stuff—including all the mining equipment—is slated for France.

Up to last week, about the only industrial commodities authorized for purchase by Marshall Plan countries were raw materials such as tin plate, steel mill products, zinc, copper, lead, aluminum, nickel, basic slag, and brass scrap. All told, upwards of $45,000,000 of such raw materials have been authorized for purchase in Western Europe by ECA.

Last week's authorizations of $215,000,000 brought to $608,800,000 the total of all commodities ECA has authorized for purchase by Marshall Plan countries, including China and Trieste.

•

Hawaiian Electric Plans Will Require $11,000,000

Hawaiian Electric Co, which has a physical plant valued at $39,000,000, proposes to spend more than $11,000,000 in expansion in the next three years.

Approximately $10,300,000 will go for boiler and turbine equipment, additional transmission lines, and substations. The rest will go for miscellaneous building expansions and equipment purchases.

The biggest single item will be $6,300,000 for a new 40,000-kw generator and plant at Hawaiian Electric's new Waiau plant, on the shores of Pearl Harbor. The new generator—the company's No. 4 unit—will be an exact duplicate of one installed last year.

Construction of new transmission lines into the growing residential area on the so-called "windward side" of Oahu, across the mountains from Honolulu, will require $500,000. About $3,500,000 will be spent on substations, line extensions, transformer vaults, additional meters, and secondary system.

The present program calls for spending $2,317,519 this year, $3,545,000 next year, and $5,275,000 in 1950.

Office Building to Have Heat Pump Installation

The heat pump will play an important part in the office building of the Appalachian Electric Power Co now under construction at Roanoke, Va.

A heat pump system, using air as the heat source, will supply the entire six floors with fully automatic year-round air conditioning. Heating alone will be supplied to an adjoining garage.

The heat pump system will consist of three 75-hp, reciprocating freon F-12 compressors. Each will have its own heat dissipating and heat absorbing coils together with the necessary connecting piping to give three separate, independent indirect systems. The systems are called indirect because water is used to transfer the heating and cooling effect from the refrigerant to the air in the conditioned space.

The three compressor-coil combinations will satisfy heating requirements at outdoor temperatures of 15F and above, and cooling requirements at 95F or below. When temperatures exceed these extremes, two water storage tanks, filled with hot or cold water, depending on the cycle, will supplement the capacity output of the compressor. These storage tanks are charged at mild outdoor temperatures when compressor capacity in excess of requirements is available.

A domestic water heat pump will be installed to furnish the hot water requirements of the building. This heat pump will heat 50 gal per hour of water from 50 F to 120 F, using ambient air as the heat source.

Coal Settlement Will Lead Electric Utilities to Seek Added Revenues

The latest coal settlement with John L. Lewis probably will lead a number of power companies to seek additional revenues—either through rate increases or other adjustments to their rate schedules. Whether it will spark a broad move within the industry to raise rates is doubtful.

This was the concensus of a number of industry experts this week (June 30).

The coal settlement—$1 per day plus 10 cents per ton additional for the welfare fund—will add a minimum of 26.6 cents per ton to the mine-mouth cost of coal. The National Coal Association figures cost increases of about 50 cents. Whatever the final increase in cost of coal, the settlement emphasizes a problem which has grown increasingly pressing in the power business—that of more revenues.

Fight Shy of Rate Increases

So far, with the exception of coal clauses for large users, the power industry has avoided rate increases as an answer to the problem posed by fixed rates in an inflationary period. Compared with other regulated industries—communications, transport, and gas—electric power has shunned rate boosts almost completely. The little it has done has tended more toward "revenue increases" than toward rate increases. Detroit Edison's two requests—for permission to cut its bill discount and to install residential, rural, and commercial fuel surcharge—are more typical than the general rate increases sought by such companies as Potomac Electric, Central Maine, and California Electric Power.

Increases so far Just Talk

In recent months, there has been increasing discussion of rate increases by the power business. Thus far, most of it is only talk. That's one reason the experts think the time has not yet arrived for a broad industry movement to increase rates.

Another reason is the varying impact upon individual companies of the inflation in operation costs. Not long ago, ELECTRICAL WORLD discussed rate matters with 10 Midwestern systems, large and small. These companies were unanimous in the feeling that residential and commercial rate boosts would have to be resorted to by the industry at one time or another if costs continued unstabilized. But only one of them saw an immediate need for rate action on its own system. And it chose a revenue increase rather than a formal rate change.

Of the others, one had just undergone a rate cut and a second had just escaped one. A third felt that if it sought a residential and commercial rate increase, it might receive a cut. A fourth doubted its ability to prove the need for a residential or commercial boost. A fifth saw non-industrial rate increases a year away—and then justifiable more as a means of preserving the company's investment attractiveness than as a means of avoiding distress.

A sixth, because of new plant already in service and a very successful refinancing, still hasn't been squeezed to the point of considering rate action seriously. A seventh thinks it can hold out long enough, with coal clauses it has installed and a very high level of business, to replace two very high-cost plants with modern equipment. An eighth was sure rate action would have to come sometime—with no idea when, but not soon. The ninth had no plans for rate action.

Whether these ten companies are representative is an open question. But their other comments indicate that they at least intend to work a lot harder on other opportunities to raise revenues than on the opportunities afforded by the non-industrial rate schedule. And so do the actions of companies throughout the land.

Where Cincinnati sought a rate increase, Georgia and Detroit sought to cut discounts. Where California Electric Power sought a rate increase, Georgia Power & Light, Florida Power, and Florida Power & Light extended fuel clauses to residential and commercial customers. The feeling is that this approach will be the standard one for a while longer. But it is agreed that the coal settlement will be sufficient to make up the minds of some companies which have been sitting on the fence about rate action.

Success a Penalty

Probably, the issue will be settled finally, if costs continue to mount, by the effectiveness of alternative means of raising revenues and increasing net earnings. Intensified efforts are being made to design new plant for the most economical construction. For many companies, new equipment will yield large savings in fuel costs. But some, whose equipment has been worked on constantly to achieve the maximum fuel economies, will suffer because they have been "too successful" in the past. Where system fuel rates were excellent before inflation, there isn't much to be realized from the installation of the best capacity available, even in large quantities. This situation is troubling two major Midwestern electric companies today.

Whether money rates will continue to afford the savings they have in the last decade will have its effect upon electric rates. Refinancing left a lot of operating income in the till, but refinancing has been only a trickle, if that much, in the last year or more. And the speculation is that if the Republican administration, which seems ticketed for Washington next year, does anything on money rates, it will raise rather than cheapen them. On the other hand, the perked-up stock market could make the industry's financing job a lot easier. If it did, it would ease a strain on the rate structure which arises from the necessity of improving earnings before selling stock.

Selective Selling a Help

Selective selling is another method of helping the revenue problem without disturbing rates—one which industry leaders feel may be of considerable significance. And increasingly, there is complaint against industrial rates as being non-compensatory, even after the heavy application of coal clauses. Increased net from industrial revenues could soften any blow to residential or commercial rates.

Curls Cooled by Coolie

A Peiping coolie cooled off Peiping's power system recently—to the tune of a cool 400,000,000,000 Chinese dollars. This heated up the power company so much that it plans to sue the coolie's employers—for a cool $35,000.

It all happened when the coolie used a bamboo pole to adjust a matting sunshade in Peiping's west city. Inadvertently, he knocked two wires together. The resulting short circuit:

1. **Burned out 440 yards of line.**
2. **Damaged many electric installations.**
3. **Ignited a policeman's uniform.**
4. **Shocked a number of women who were getting permanent waves at the time.**

In U. S. currency, 400,000,000,000 Chinese is about $35,000.

HONOR GUARD stands at attention as President Miguel Aleman of Mexico departs from the inaugural session of the summer meeting of AIEE at Mexico City. Left to right are Oscar R. Enriquez, president of the meeting; President Aleman; Blake D. Hull, AIEE president

Mexican and U.S. Engineers Trade Information at Meeting of AIEE

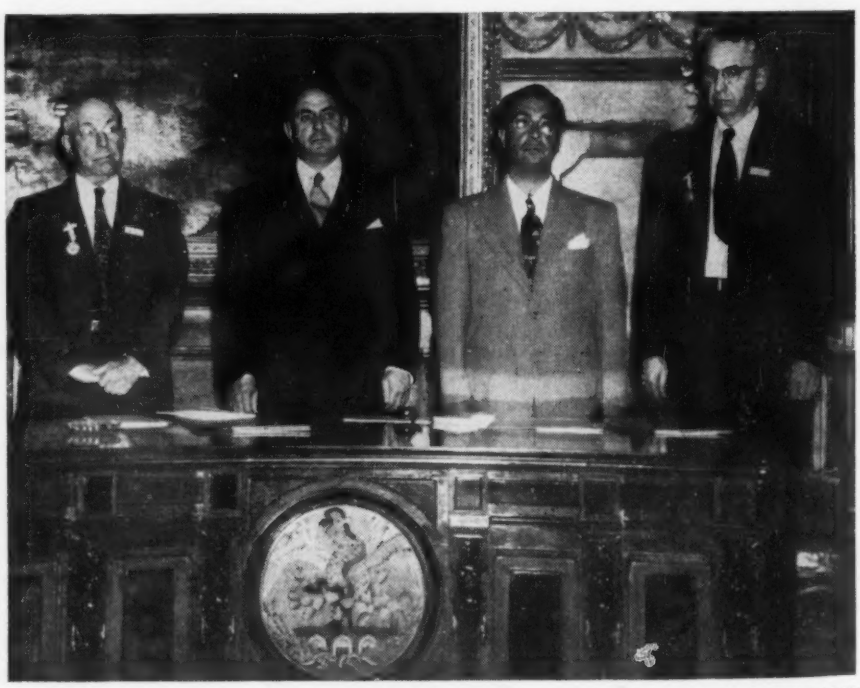
EXCHANGE of information about electrical trends in the respective countries typified the tenor of the technical sessions of the summer general meeting of the American Institute of Electrical Engineers at Mexico City, June 21-25. Leaders of governmental and corporate agencies told of the evolution and status of Mexican hydro, power systems, steel, paper, and textile industries. Papers from the United States reciprocated by recording the state of the art in a wide gamut of electro-technical fields. These embraced utility and industrial power systems, switchgear, relaying, power generation costs, lightning resistant lines, standardization, induction and dielectric heating, welding, electrification of oil pipelines and production.

In addition there were committee reports on trends in the conductor situation and in the control of system overvoltages. Other significant papers were a recital of the program of changing frequency on the Southern California Edison system from 50 to 60 cycles and a description of the Grand Coulee hydro system.

Signal honor was conferred on the Institute by the participation of President Miguel Aleman of Mexico and the governor of the federal district at the opening ceremonies at the Palace of Fine Arts. This was followed by a noon banquet tendered by Antonio Ruiz Galindo, Minister of National Economy and chairman of the Federal Electricity Commission. The 1,500 present included over 500 from the United States and several from South America and Africa.

Mexico has under way a large hydroelectric program to develop the ultimately practicable 10,000,000 hp. So far only 511,000 kw have been installed with firm-demand capacity of about 250,000. Andres Garcia Quintero of the Ministry of Hydraulic Resources estimated that it would take the Mexican equivalent of 2 billion dollars to fully develop the 14,000,000 kw of capacity required to make full justifiable realization. In short the program is only 3.4% completed.

The rainfall runoff and arability, however, are such that most of the projects will have to embrace irrigation as



HONORARY CITIZEN of Mexico City was the honor bestowed on Blake D. Hull, left, AIEE president, by Mayor F. Casas Aleman, second from left, at this ceremony. H. H. Henline, AIEE secretary, is at the extreme right. The fourth man is a Mexico City councilman

PROMINENT MEXICANS who helped make the summer meeting of AIEE a success pose with their American colleagues. Left to right are Jaime Torres Bodet, Minister of Foreign Relations; E. J. Housley, former AIEE president; Adolfo Orive Alba, Minister of Hydraulic Resources; Gual Vidal, Minister of Education; A. P. Urquidi, Federal Power Commission; and R. F. Danner, Special Coordinating Committee

well as power. Adolfo Orive Alba, Minister of Hydraulic Resources, pointed out that only 7% of Mexico's area is sufficiently humid to grow crops. Top soil is not too fertile. Rainfall is often torrential and runoff erratic. Even with drainage and sanitation only 7.5 million acres could be cultivated without irrigation. Most optimistic additions elsewhere would, he said, provide only 1 acre per inhabitant whereas the U. S. has practically 3.

President Aleman has advocated an outlay of $300,000,000 for such irrigation as an accompaniment of hydro power. One of the largest of the tropical rivers, the Papaloapan, will have a flood control feature as well as irrigation and power and has therefore been dubbed the Mexican TVA.

Discussion at some sessions was active but generally limited in scope. At the protective devices session S. E. Schultz of BPA asserted that $400,000 additional expense for 10,000,000-kva circuit breakers had averted the $20,000,000 or so expenditure that would otherwise have been necessary for stable and reliable sectionalized operation of the Bonneville system.

R. L. Webb said that unit type substations for auxiliaries in Consolidated Edison plants will be located at strategic points near large motors to shorten runs. Orders recently placed for 4 to 13-kv circuit breakers to the extent of $2,000,000 will be 98% of the oilless variety. Schultz added that much less expensive breakers for tap lines to local loads off-high tension rings would tend to greatly facilitate serving local concentrations of load along the lines.

V. G. Vaughan of Spencer Thermostat Co said that 40% of the fractional horsepower motors in the U. S. have thermal protection. Others urged extension of the automatic protection to integral horsepower and large motors in general.

Electrical, cement, paper, refractory, plastic, steel, textile, and other industrial plants were visited as well as the hydro and steam plants of the Mexican government and the local utility company.

In the closing ceremonies on Friday A. P. Urquidi, chairman of the Mexico Section AIEE, said Mexico is entering one of the most promising periods of its history. Technical, economic, and moral objectives have been set high, and the help given the program through the papers was deemed worthy of much appreciation. Those present from north of the border manifestly felt the same regarding what they learned about Mexico.

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Sydney Has Troubles, Too

Sydney County Council, the city's power authority, will order a new 50,000 kw turbo-generator and boilers to serve it. The equipment to be installed at Bunnerong station will set a new high for Australia with a capital cost of $240 per kw.

Demand in Sydney and suburbs is increasing 50,000 kw a year. Slow delivery schedules have made it impossible to keep abreast of demand. Standby plant has to be operated even in normal periods, and load shedding and blackouts are the only ways to cope with peak loads.

Pacific Power Authorized to Double Ariel Capacity

Pacific Power & Light Co got the green light recently (May 28) from the Federal Power Commission to double the hydroelectric generating capacity at the company's Ariel Dam. The new 55,000-hp generating unit will be the first major addition to a privately-owned utility's hydro plant in Washington in recent years.

FPC's approval of the company's application was interpreted as another indication that expansion of federal hydro development in the Pacific Northwest has not been rapid enough to meet the area's mounting energy demands. The commission's order stated that the proposed addition is "needed to supply present deficiencies in generating capacity" in the Northwest. The new energy, FPC added, will be "valuable in easing the tight power situation in the Pacific Northwest Power Pool."

PP&L's Ariel Dam, located on the Lewis River, was built under a federal license issued in 1929. Authorization of the new unit called for installation within two years.

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Stock Shift 87% Complete

Portland General Electric Co has announced that exchange of PGE stock for securities of its former parent, the Portland Electric Power Co, is 87% complete. New PGE stockholders total approximately 10,300. More than 58% of all outstanding PGE stock is held in Oregon, California, Washington and Idaho.

OHIO PUBLIC SERVICE CO used this booth to demonstrate advantages of electricity to the farmer at the Farm Electrification Demonstration on the Ashland County Fairgrounds

NELPA Personnel Men Study Employee Matters

Job evaluation, merit rating, employee selection and training and accident prevention were principal subjects discussed by delegates to annual conference of the Northwest Electric Light & Power Association's Personnel Section at Medford, Ore, recently. O. A. Petersen, B. C. Electric Railway Co was chairman.

One day was devoted to accident and fire prevention in a conference of safety directors of member companies. They sought closer cooperation of the Northwest group with E. E. I's accident prevention committee.

John C. Boyle, vice president and general manager, Glenn L. Jackson, vice president, and H. P. Bosworth, Jr., assistant to the general manager, California Oregon Power Co, addressed luncheon and dinner sessions. They described Calepco's development of the Rogue, Klamath and Umpqua Rivers for irrigation and power. This development is now going forward with a new project at Tocketee site on the Umpqua. To build up the economy of the region, the company is encouraging establishment of lumber-finishing plants. These increase the man-hours of labor in lumber employment and add to the value of the finished product in the region's fastest growing industry.

The session on accident prevention and safety was lead by C. C. Haggard, California Oregon Power Co. A survey of automobile accidents among the member companies by J. E. Yates, Pacific Power & Light Co, indicated a need for driver training.

Essential factors in fire prevention are good housekeeping, training of men in the operation and use of fire protection equipment, and regular inspections, according to T. J. Rigby, The Montana Power Co. R. H. Elfstrom, B. C. Electric Railway Co, pointed out the importance of supervisory training in accident prevention. Any such program should be fully supported by top management, he said.

Procedures in selection of new and transfer of old employees were revealed in a survey by R. B. Middleton, B. C. Electric Railway Co. It indicated a trend toward more scientific selection. In the B. C. Co, all applicants take a series of tests, including one given by a trained psychiatrist. Some companies post all available jobs to give employees opportunity for transfer to better positions. All such applicants are tested the same as new employees. Interviewing of every applicant was viewed as a public relations activity. Many companies are resorting to exit interviews. Here again, the public relations value of such procedure is considered.

All companies are carrying on training programs to varying degrees, according to S. E. Skelley, Pacific Power & Light Co who discussed training programs, methods and techniques. Both on-the-job training and employee information programs were outlined. Necessity for training supervisors was emphasized.

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Kentucky Utilities Assessed

Utilities in Kentucky have been assessed $100,000 to support the Public Service Commission for the 1948-49 fiscal year. The levy is based on gross operating revenues of the companies controlled by the Commission.

SEC RULINGS

NORTH AMERICAN Co has been given permission to distribute to its common stockholders of record June 4 about 239,599 shares of Wisconsin Electric Power Co common, plus about $283,474 in cash instead of fractions of Wisconsin stock. (Release No. 8217).

NEW ENGLAND POWER Co, a subsidiary of New England Electric System, has received the green light from the SEC on its application for solicitation of the holders of its publicly-held 6% cumulative preferred stock and the holder (New England Electric System) of its common stock. Solicitation is with reference to (1) the reduction in the par value of the common stock of NEPCO from $25 a share to $20 a share, being an aggregate reduction in par value of $3,111,665, (2) an amendment to the By-laws of NEPCO to so provide and (3) a restatement of accounts in connection therewith. (Release No. 8229).

WISCONSIN PUBLIC SERVICE CORP has been authorized to borrow $2,000,000 from banks. The money will finance temporarily construction, pending completion of a permanent financing program for 1948. (Release No. 8263).

MISSOURI POWER & LIGHT Co, a subsidiary of North American Light & Power Co and The North American Co, both registered holding companies, has obtained SEC clearance to borrow $1,500,000 from the Chase National Bank of New York, issuing as evidence of such borrowing an unsecured promissory note in the amount of $1,500,000, payable on or before Mar 1, 1951, bearing interest at the rate of 2¼% per annum, payable quarterly. Proceeds are proposed to be used in the retirement of two presently unsecured outstanding notes held by Chase, aggregating $740,000, which mature Sept 22, 1948, bearing interest at the rate of 1⅝% interest per annum, and for the partial financing of construction expenditures. (Release No. 8279).

APPALACHIAN ELECTRIC POWER Co, a public utility operating subsidiary of American Gas & Electric Co, has been permitted to form and acquire stock of Central Appalachian Coal Co, a new corporation to be organized for the purpose of developing and operating a coal mine and for transporting, buying and selling coal in the interests of Appalachian and the other power companies forming a part of the central system of American Gas & Electric Co. The new company, which is to be a wholly owned subsidiary, will have an authorized capital stock of 60.000 shares, par value $100 per share, of which 40,000 shares will be issued to Appalachian prior to Mar 1, 1950 for a cash consideration of $4,000,000. The cash obtained by the coal company will be used to purchase mining and barging equipment, to construct surface facilities and to develop and operate the mine. (Release No. 8285).

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Utility Voted Franchise

Voters of Brookfield, Mo., have approved a ten-year franchise for the Missouri Power & Light Co.

Enforcement of "Overtime" Ruling to Begin Sept 15

Enforcement of the Supreme Court's new "overtime-on-overtime" principle under the Wage-Hour Law won't begin until Sept 15, instead of July 1. Wage-Hour Administrator William R. McComb advises. The reason: to give management enough time to adjust its overtime pay practices and also permit possible revision of contracts that are reopenable.

This, however, does not protect employers against individual claims for overtime wages due under the new principle between June 7, when the court decided the longshoremen's case, and Sept 15. It simply means that, in any violations discovered by Wage-Hour agents after Sept 15, no claims will be made by Wage-Hour for overtime due before Sept 15.

Some employers outside longshoremen will first feel the bite of the new rules next week, when the July 4 holiday occurs. Under the Supreme Court decision, time-and-a-half which many employers will pay for work on that holiday is not "overtime" and may not be credited against overtime due under the law if the employee works more than 40 hours. If he does not work more than 40 hours that week, there is no problem.

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Westinghouse Announces Equipment Price Raises

Five and ten percent increases in the price of electric motors, engine-driven generators, and industrial control equipment were announced this week (June 30) by the Westinghouse Electric Corp. They became effective at midnight, July 2.

The price boosts, which were attributed to recent 9-to-16-cent-wage boosts given by Westinghouse and to increasing prices of materials and services purchased by it, covered about the same equipment as was recently raised in price by GE, with the exception of certain appliances.

The 5% increase will affect: small and medium motors of 1 to 200 hp, engine-driven generators of approximately 150 kw and smaller, and motor generator sets made up of these items.

The 10% increase will affect all industrial control equipment.

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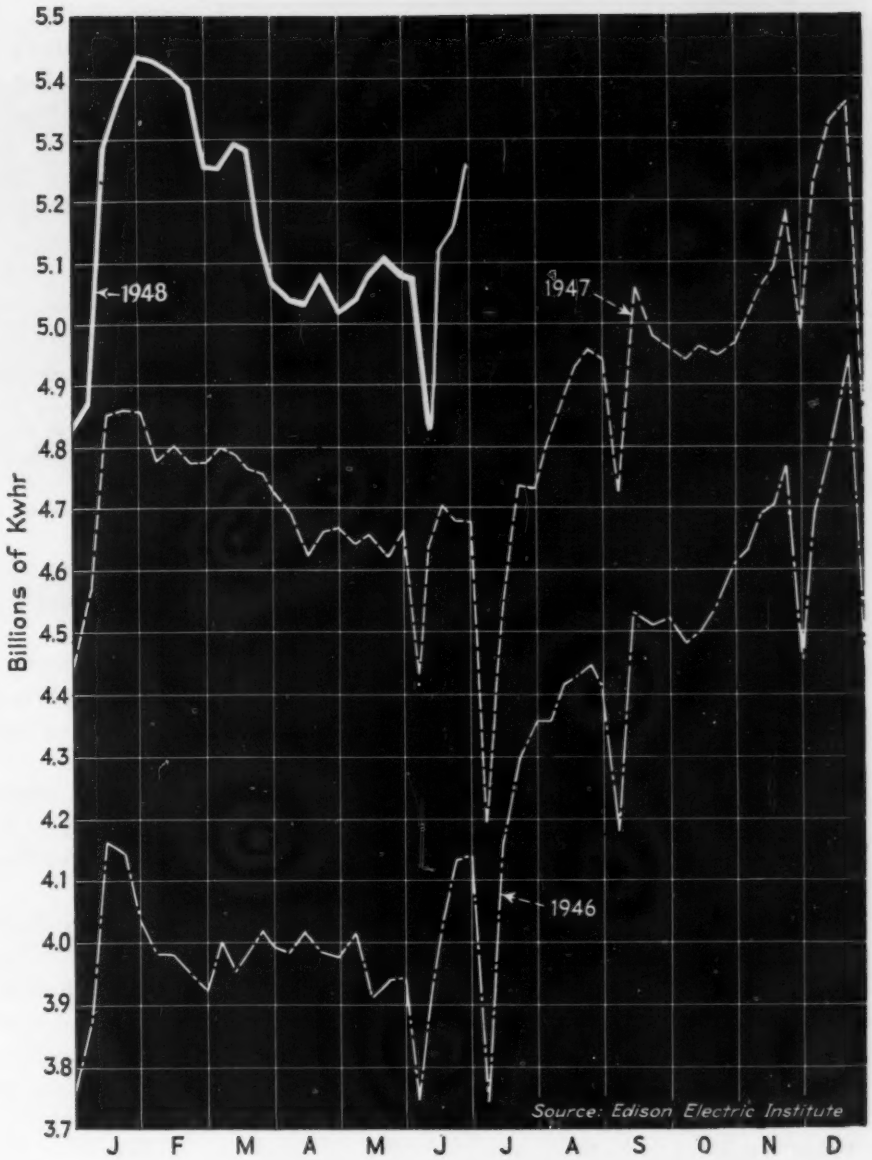
Lightning Hits Erie Sub

Lightning struck a Pennsylvania Electric Co sub-station at Erie, June 8, burning up a 13,800-volt trunk switch. Power was out for more than four hours in some sections.



Arput's Dream Pictures a Muddled U.S.

ARPUT woke up screaming the other night. He hasn't dared dream since.

"It was that last-minute rush Congress had to get out of Washington," he shuddered. "When everyone was in Philadelphia and Truman had signed all those bills they crammed through, someone discovered they'd passed a bill outlawing Congress. And there was another, making the Supreme Court take a year's vacation. Where were we then? In trouble!

"You can't find either bill unconstitutional. No Congress to repeal the law. And this Truman wants no executive order re-constituting the 80th Congress. Things were really up in the air—just like the output this week."

Other News

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Weekly Output, Millions Kwhr

1948	1947	1946
June 26 5,257	June 28 4,675	June 29 4,133
June 19 5,159	June 21 4,676	June 22 4,129
June 12 5,132	June 14 4,702	June 15 4,030
June 5 4,845	June 7 4,635	June 8 3,920
May 29 5,076	May 31 4,429	June 1 3,741
May 22 5,085	May 24 4,663	May 25 3,942
May 15 5,109	May 17 4,616	May 18 3,939
May 8 5,087	May 10 4,653	May 11 3,911

Percent Change from Previous Year

	June 26	June 19	June 12
New England	+ 9.4	+ 9.4	+10.7
Mid-Atlantic	+10.4	+ 8.4	+ 7.5
Central Industrial	+13.4	+10.7	+10.9
West Central	+16.4	+14.3	+13.2
Southern States	+17.0	+16.1	+11.5
Rocky Mountain	+ 7.3	+ 8.1	+ 9.0
Pacific Coast	+ 6.8	+ 2.0	+ 1.6
Total United States	+12.4	+10.3	+ 9.1

WASHINGTON COMMENT

WILLIAM B. WHICHARD

REPUBLICANS who supported Democratic Senator Byrd in blocking pay raises for top federal administrative officers are likely to regret it. Over the long term, their action may add to the difficulties of a new GOP President trying to fill Washington jobs next January with high-caliber executives. In the meantime, Uncle Sam is likely to lose more of his really able federal officials.

Senator Byrd led the successful attack on efforts by Republicans Taft, Flanders and Baldwin to include pay raises for appointive officials in the legislation giving postal employees an additional $450 per annum and raising general Civil Service salaries $330 yearly. The Taft-Baldwin-Flanders proposal might have lost eventually in the House, it is true. But Senator Byrd, with the help of Republican votes, prevented its going that far.

Despite his knack for drafting good men into state jobs in New York, Governor Dewey, if he is elected in November, probably will inherit from Truman the knotty problem of getting able executives for top federal jobs of less than cabinet rank. The enormous prestige that accompanies a cabinet post still attracts plenty of takers at the going salary rate of $15,000.

But there are other jobs of high importance which command less salary and considerably fewer kudos. These range from the under-secretaries and assistant secretaries of the departments, through top officers of the various independent agencies and commissions, to chief administrators of vast departmental programs. For most, the salary has been frozen at $10,000 per year. Holders of these jobs are the men finally responsible for the regulation, financing and development of vital segments of the economy. In jobs of comparable responsibility in industry, most would get much more.

As a Congressman recently commented, it is one of the marvels of the age that so many able $10,000-a-year officials have remained in federal service. Many have quit, simply because they could no longer ignore opportunities in private industry. Others are likely to follow on the heels of the Senate's refusal to pass the Taft-Baldwin-Flanders increase.

Effects of the Civil Service pay raise points up their plight. For example, four employees of Federal Power Commission will receive $10,330 annually under the new law. Eight other staff members will get $9,700 or more. Their "bosses," the commissioners, stand pat with $10,000. Securities and Exchange Commission, which has suffered a heavy turnover among its $10,000-a-year commissioners, will have nine staff aides at $10,330, one at $10,305 and one at $9,975.

Similarly, the Rural Electrification Administrator, who is charged with lending $400,000,000 in Federal funds during fiscal 1949, will get $10,000 for the job. His top aide will get $330 more in cash and much less of the responsibility. The Reclamation Commissioner, scheduled to direct a $230,000,000 construction program authorized by Congress recently, will have 30 or more Civil Service aides who draw more pay.

The raises proposed in the Taft-Baldwin-Flanders formula may have been inequitable, as Senator Byrd insisted. But some adjustment of these salaries sooner or later must be made unless business, agriculture and the people who are most affected by such job-holders are willing to deal with incompetents.

TECHNICAL TRENDS

ARCHER E. KNOWLTON

Microwaves of 1.25 centimeters look promising as a means of spotting approaching storms and hurricanes.

Rubber gloves are being used in conjunction with insulated platforms to do work on energized 12.5-kv circuits. For 13.2 kv delta one corner is grounded.

Trees will produce in lumber only slightly more than a third of their volume. Poles are far less wasteful of nature's growths.

Frozen coal constitutes an annoying and expensive problem still defying a universally happy solution. Ten-pound sledges are too often the resort.

Silica in turbine blading is considered less troublesome along the seacoast. Condenser leakage introduces brackish water which has some not-well-known ingredient that inhibits silica deposits.

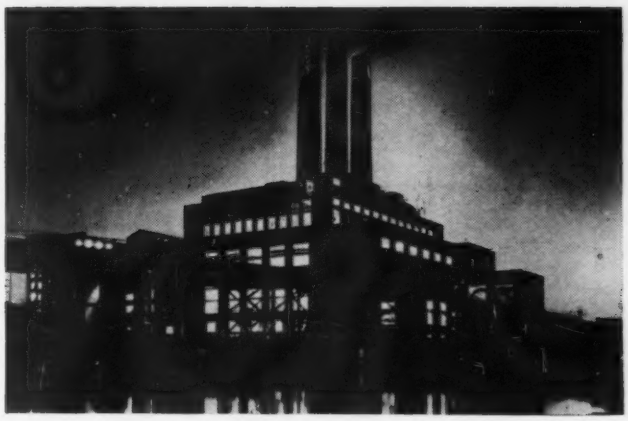
Two-motors-on-one-breaker does save breakers in the auxiliary section of a power plant, but the operators demur because they have to shut down to isolate a defective motor, fan or pump for maintenance.

Soot-blowing with air may cost more to install but boiler maintenance may be reduced. Use of steam increases water consumption and may necessitate more blowdown to control silica.

Reclosure of customers' circuits is a common practice. What is so different about substation and station auxiliary circuits that precludes doing it there, too?

Some evaporators seem to be over-rated and are operated at half or less capacity to insure adequately clean output.

Electric fatalities in and around stations constitute 30% of the total electrical fatalities on the system. Line accidents get more publicity and maybe more attention.



5th Steam Station Cost Survey

A. E. KNOWLTON
Senior Associate Editor
ELECTRICAL WORLD

INTEREST IN DESIGN of steam power plants is at a high pitch and justifiably so for several cogent reasons. More plants are being built than at any previous time. They are costing more to build. Fuel and manpower are costing more. The following pages evidence those soaring costs.

No better index of the concern of managements about this situation can be found than the prompt and favorable response to Electrical World's inquiry early in the year and the hearty contribution of filled-out questionnaires. Data was sent in covering 113 stations, twice as many as for the Fourth Steam Cost Survey (1939) and well over five times as many as for the Third survey.

Managements and engineers alike are keenly conscious of the necessity for a sharp balance of such factors as dollars per kilowatt, Btu per kilowatt-hour, mils per kilowatthour, employees per kilowatt and various space and volume indexes. The monuments which may be built in this present era will be monuments of economic balance and few, if any, will be monuments to technological frontier-pushing. That is the conclusion drawn from the expressed desire for the data compiled and interpreted in the ensuing pages.

The information was sought, translated, arranged and digested in such manner as to bring out the items of interest most commonly indicated. Intent has been to present the quantitative and qualitative items so that they will be most useful to those who want to bore in and deduce their own indications. The charted analysis accompanying the tables focuses on the major points of interest with no intention of judging or prejudging.

It is believed that the questions raised represent the issues most directly involved in achieving an optimum plant for any existing combination of circumstances. Admittedly some companies did not have the requested data in the form requested but the great majority of them valued the significance enough to make the computations, nevertheless. In general the data are reported as they were contributed. But there were instances of manifest inconsistency and they were handled by substituting consistent data.

It is no simple matter for one person to collect and digest all the items of data in the 16 pages of tables which follow. The task was a pleasurable one because the information presented should be useful for several years. Designers and manufacturers were still asking for copies of the 1939 survey while this one was in process. If they repeat, it can only mean that the uniquely available figures are truly useful in proof-checking the designs for the millions of kilowatts which continue to be demanded.

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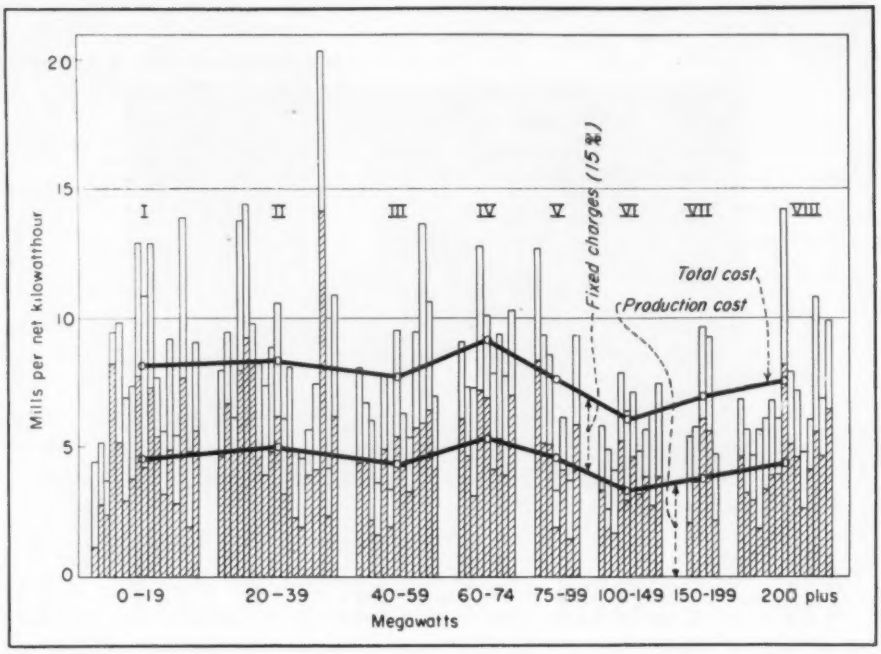


FIG 1—PRODUCTION EXPENSE and fixed charges vary widely but their total averages to some 7½ mills across the nation

Power Generation Costs in 1947

All factors of cost had risen. Production cost up 50% since 1938. Fuel and wages largest factors. Investment per kilowatt rising sharply

ENERGY GENERATED in representative USA power plants in 1947 cost nearly a half more than in 1939. A fair average across the country shows production costs ranging from as low as 1.5 and as high as 14 mills with an average value of 4.5 mills per net kilowatt-hour (Fig. 1). Nine years ago the corresponding figure was approximately 3 mills.

Costs Have Risen

Total cost of generated energy—including the carrying charges on investment—has therefore risen. With a much larger sampling to base the conclusion on, it appears however, that the *overall* costs in 1947 did not exceed by as much those of 1939. It is doubtful if this can be said about prospective 1948 costs and much more doubtful for ensuing years because of the sharp increases in operating, equipment and structural costs now being experienced. Included in the 102 stations here presented in graphical analysis are several that were built in the 1930-1945 period when costs were substantially lower than they have now become and similarly lower than the 1920-30 decade.

As a consequence of these influences the average cost of net kilowatthours at the bus for plants from 5,000 to upwards of 300,000 kilowatt rating in 1947 was about 7.5 mills (Fig. 1). Since the average production cost appears to be 4.5 mills the fixed charges can be set down as 3.0 mills on the broad average basis.

Average Cost Horizontal

In reacting to or applying these inferences it should be remembered that (1) they apply to 1947, (2) that the spread of total generated cost is from less than 3.5 mills to over 20 mills and (3) that the spread of the maximum by size groups is from something over 6 mills to something over 9 mills. In other words local circumstances must be recognized in measuring one station with another.

That this is true is no more forcibly demonstrated than by the apparent fact that the smallest stations have as low production and total costs as do the largest, group by group. This contradicts the customary belief for several reasons associated with the specific data under analysis. Many of the small stations (up to 39,000 kilowatts) in the tabulation are in territory where fuel costs in cents per million Btu are low and some are located where labor costs, land costs and structural costs are low. Their thermal efficiency is generally poorer, they operate at lower pressures and crowd their capacity more. Nevertheless the lower costs all around offset the adverse factors well enough to match quite well the overall costs at the largest plants where fuel may cost up to 8 times as much per million Btu and where land, buildings, operating

and maintenance staffs all cost more. In short, the largest stations are mostly in metropolitan areas where load justifies large size and every effort to achieve maximum economy to offset higher costs.

That these factors in metropolitan areas are adverse may also be seen in the plat of data (Fig. 1) for stations in Group VI (100-149 megawatts). As a group they reflect the lowest average costs both for production and for carrying charges on investment. They are less commonly located within the cities, the cities served are moderate in size and the penalties of congestion have been avoided.

Another factor should be recognized in reading these data and conclusions. It is that they are by no means confined to new plants. They pertain as well to plants with units in some cases installed as early as 1910. The prevailing pressure for output has forced the retention of these older and comparatively inefficient boilers and turbines. Whether their ultimate elimination will raise or lower the average cost of a kilowatt-hour at the bus depends wholly on the uncertain costs of the uncertain future.

Intensive Utilization

Still another point worth noting in connection with these cost data is the high values of utilization and plant factors and the consequent benefit to production and investment components of the costs per net generated kilowatt-hour.

So great was the load imposed in 1947 on installed capacity that only one in six of the plants was subjected to a peak below its rated capacity. Peaks were commonly up to 120-130 percent of rated capacity, a testimonial to the margin of capabilities built in by the manufacturers of the equipment. The efficiency at this loading may not have been optimum, of course. The plant factor (ratio of actual net output to that obtainable over 8760 hours of full rated capacity operation) was even more favorable. Except for the largest plants the national (sampled) average was about 70 percent in 1947.

Plant Investment

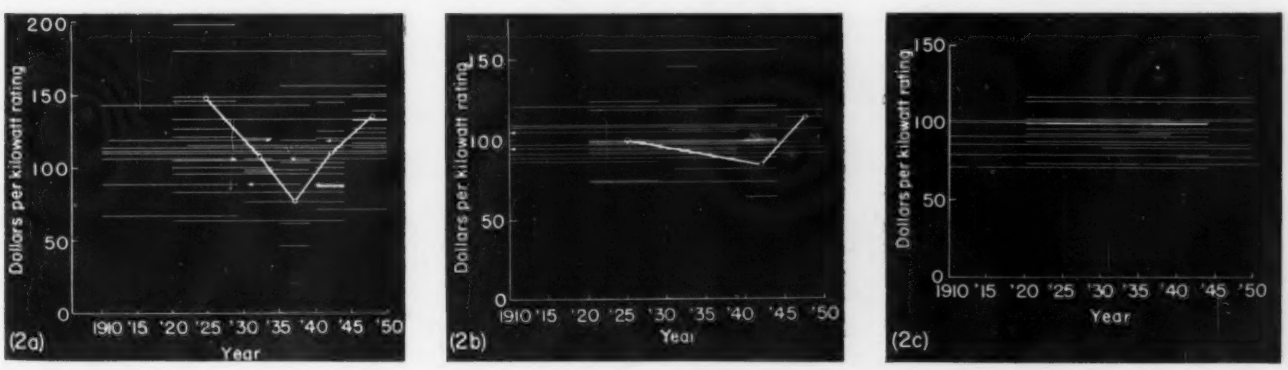
Costs dropped to a 1935 low but have risen sharply since. Boiler plant takes about 36% and turbine room 26%. High fuel costs result in more expensive plants.

A KILOWATT of generating capacity has, according to detailed reports on 102 generating stations, cost as much as $200 and at one time could apparently be set up for as little as $46. The phenomenally low value can be accounted for by simplified design to take advantage of a very low fuel cost and by resort to outdoor installation of the boiler (Fig. 2). The general average lies between $90 and $130 for plants operating in 1947, regardless of the age of the oldest operating unit.

This very factor of age of plant can completely obscure the trends over short periods during which significant factors influence the objectives in design of new plants or additions to existing ones. An effort has been made in Fig. 2 to display the facts as reported.

When an old plant has modern units added there are usually extensive realinements of the older equipments. The unit costs reported are presumably those at which the plant is carried on the books so as to reflect the retained equipment, the added equipment and the alterations to accommodate the new equipment most advantageously. In Fig. 2 a horizontal line has been drawn to represent for each plant the book value per kilowatt (not including switchyard) and stretching from the year in which the oldest unit was first operated to that in which the latest unit was first operated.

Here it is seen that the progressively larger plants, as would be ex-



Stations 0-59 Mw | Stations 60-149 Mw | Stations 150 or more Mw

FIG 2—STATIONS BUILT in 1935-40 or 1940-45 at lowest unit cost. Switchyards not included. Length of line in each instance represents interval between dates of oldest and newest units

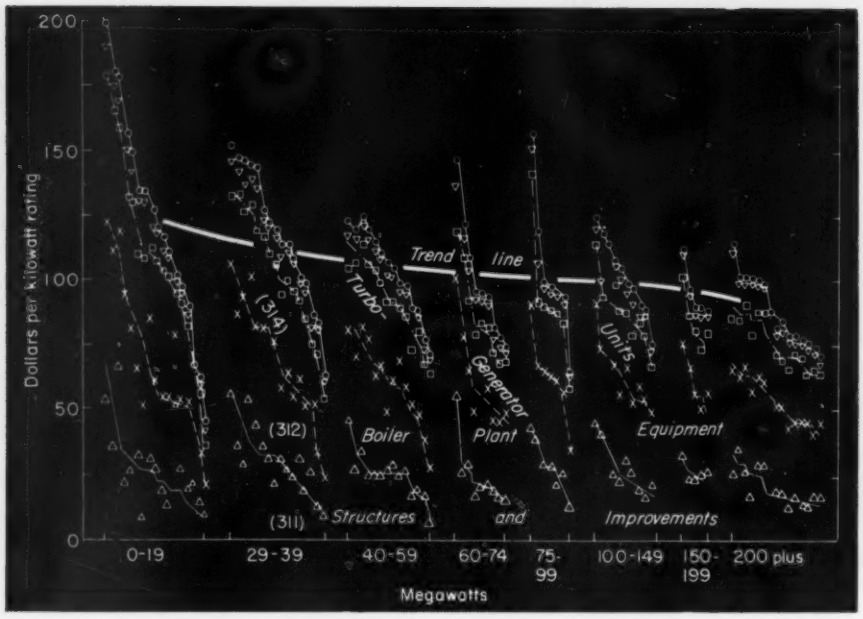


FIG 3—THE LARGER THE PLANT the less the unit cost but spread is only about $85-125 on the broad average for plants completed before 1947

pected are—on the average carried at lower costs per unit of rating than the smaller ones. In fact the very largest plants, even if quite ancient, represent lower unit costs than the middle-sized plants; the latter showed up advantageously, however, in overall costs per net generated kilowatthour (Fig. 1).

Not too much information was available to establish a trend in investment costs but certain inferences can be drawn regarding plants up to 60 megawatts and somewhat less about plants in the 60-150 megawatt bracket. There have been too few large plants (150 megawatts and upward) started and terminated in the respective decades or half-decades to warrant any conclusions about their price trend.

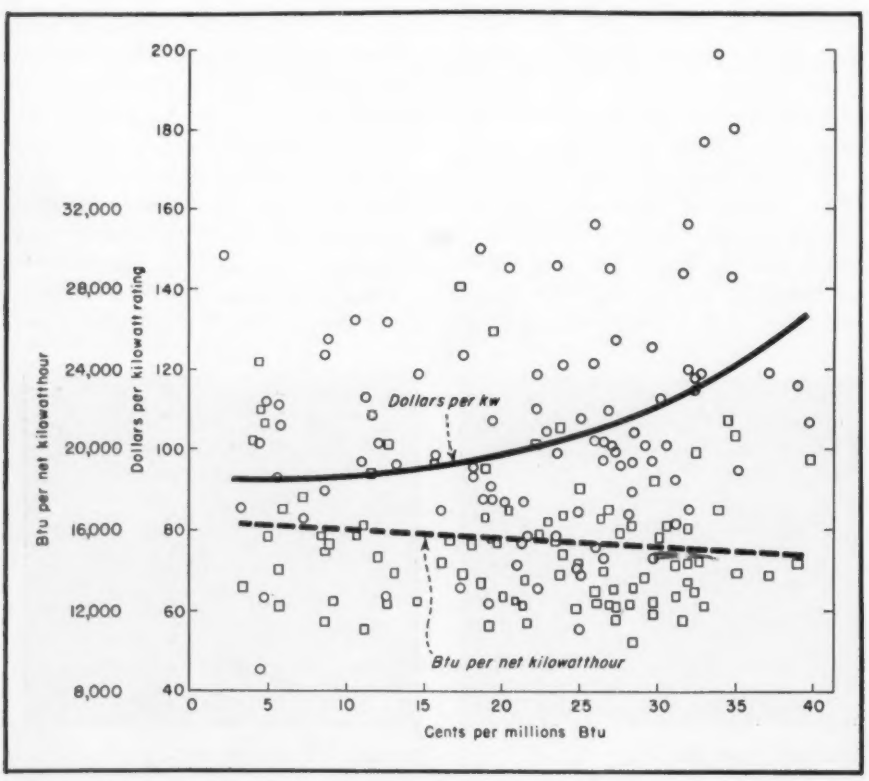


FIG 4—MORE IS SPENT for unit capacity where fuel cost is high. Thermal economy by no means linearly proportioned to fuel cost

Cost Expansion

However, the plants of less than 60 megawatts built in 1920-1929 and not since expanded cost on the average about $150 per kilowatt. Those built in 1930-34 averaged about $107 and those in 1935-39 as low as $76. By 1940-44 this unit cost had risen to $110 and by 1945-47 had soared to about $135. Note that the 1947 unit cost had not quite reached what was experienced in the inflation and boom which lasted through the decade following the first World War. The costs being experienced in 1948 in connection with new capacity are already reported to lie on an extension of the upward trend line of the 1939-50 costs of Fig. 2a.

The upturn in investment costs can also be seen in Fig. 2b in this case for plants of 60-149 megawatt rating. Those built entirely within the 1920-29 decade averaged approximately $100 per kilowatt of rated capacity. By 1940-44 the average had fallen to about $83 but by 1945-50 it rose to about $113 per kilowatt.

Reverting again to investment costs regardless of plant vintage it is evident from Fig. 3 that the spread in dollars per kilowatt is much greater for small plants than for large plants. But the general average is not so different. This has been discussed in an earlier paragraph where peculiar costs related to location were cited as the leveling influence.

Boilers Loom Large

The largest plants represent an average of $85 per kilowatt rating and the smallest about $120. Remember that these are averages of old as well as fairly new plants and merely stand for the total book entries divided by 1947 total rated kilowatts regardless of the period in which they were installed.

That the boiler plant (account 312) constitutes the largest component of overall station cost can also be seen from Fig 3. Here it should be noted that the ordinate values are all arranged in order of descending magnitude for better visualization of the trends. The structure, boiler and turbogenerator values on any ordinate are not necessarily those associated

with the corresponding total-investment ordinate. For a rough guide as to averages about all that can be safely said is that the structure and improvements (account 311) for a $100 plant amount to $28, the boilers and their associated thermal equipment (312) to $36 and the turbogenerator account (314) to an added $26. All the office space, shop, electrical galleries, etc. account for the remaining $10. Actual departures from these rough approximations are quite wide. Examination of the extensive tabulations on which this analysis is based will afford plenty of opportunity for study.

Before concluding this discussion of dollars per kilowatt, it is desirable to note the relation between unit investment and cost of fuel. This is depicted in Fig. 4. Not generally appreciated outside utility circles is the fact that some utilities, particularly large ones with plants remote from fields affording cheap fuels, pay up to eight times as much for the fuel, burned under their boiler tubes as do others, usually smaller plants, located near cheap gas or oil supplies. It has already been explained that this factor by itself accounts for the overall cost of energy in small plants being only a bit greater than in large plants, despite the advantage of better thermal performance in large plants with better heat cycles.

Outlay for Efficiency

Wherever the high cost of fuel (best expressed in cents per million Btu) is high it is logical to spend more to achieve better thermal performance. In Fig. 4 it is evident that 5-cent fuel does not justify spending much above $90 per kilowatt but that 40-cent fuel has justified over $130 per kilowatt on the average. At least the very highest values of investment per kilowatt are quite naturally associated with some of the highest fuel costs.

The added money is in some instances absorbed by higher local construction costs (the high fuel costs are generally associated with large plants in congested areas). Where not so absorbed it has manifestly been devoted to thermal refinements (higher steam pressure, higher temperature in particular) aimed at achieving a kilowatt-hour with less expenditure of heat energy. The ideal would presumably be a sharply-sloping downward curve of Btu per net kilowatt-hour of such character that the fuel-cents in the production cost would be about the same regardless of unit cost of the fuel. That this is not attained or even attainable is indicated by Fig. 4. In fact there is hardly 10 percent differential between Btu per net kilowatt-hour on the average where fuel is cheapest and where it is most expensive. The corresponding increase in the investment incurred is computed to be about 30 percent.

Plant Fuel Economics

Tapering gains from higher steam pressures and temperatures. Operating conditions in 1947 quite favorable from load angle. Plant and utilization factors at high levels

THE LARGER the station the better its thermal achievement. In fact the largest plants as a group (Fig. 5) do a 60 percent better job in using fuel energy to best advantage than the very smallest plants. However, there is much less spread in the groups above the 50 megawatt ratings. The spread within each group of ratings is wide enough, it seems, to warrant plenty of analysis toward narrowing the range and emulating the best. Of course the availability of very cheap fuel in some locations removes one sizeable incentive to achieve superlative thermal performance. Note again that the plants between 150 and 200 megawatts do the best job of all, thermally speaking.

It is self-evident that higher boiler pressures and steam temperatures afford better thermal performance. That this is true in actual practice over a wide range of station age and station loading is seen from Fig. 6. The 1200-1600 psi plants hit below 11,500 Btu per net kilowatt-hour. The 800-1000 psi plants hover nearer 12,000. The 600-700 psi plants reflect about 13,000. Finally the 200-400 psi plants range from 14,000 to 26,500. The law of diminishing returns is evidently in force in the field of heat cycles based primarily on choice of steam pressure and temperature. All these data have been entered only for single-pressure plants; i.e. the plants which have unsuperposed units operating at two or more pressures have been omitted from Fig. 6.

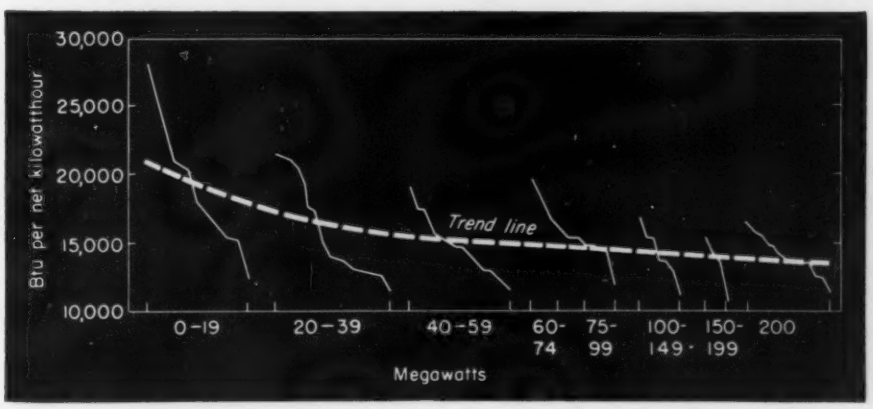


FIG 5—THERMAL ECONOMY on the average is a third better for the largest stations than for the smallest

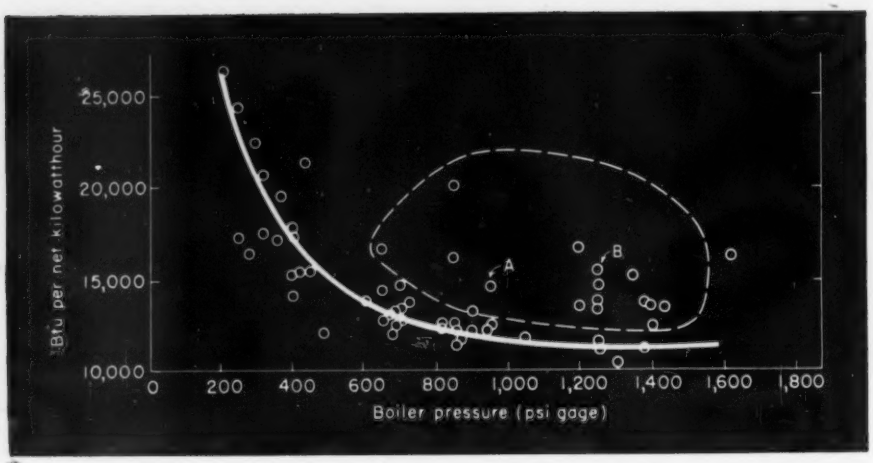


FIG 6—HIGHER PRESSURES and temperatures achieve better fuel economy. Superposed units (all in the oval except A and B) not in best economy levels

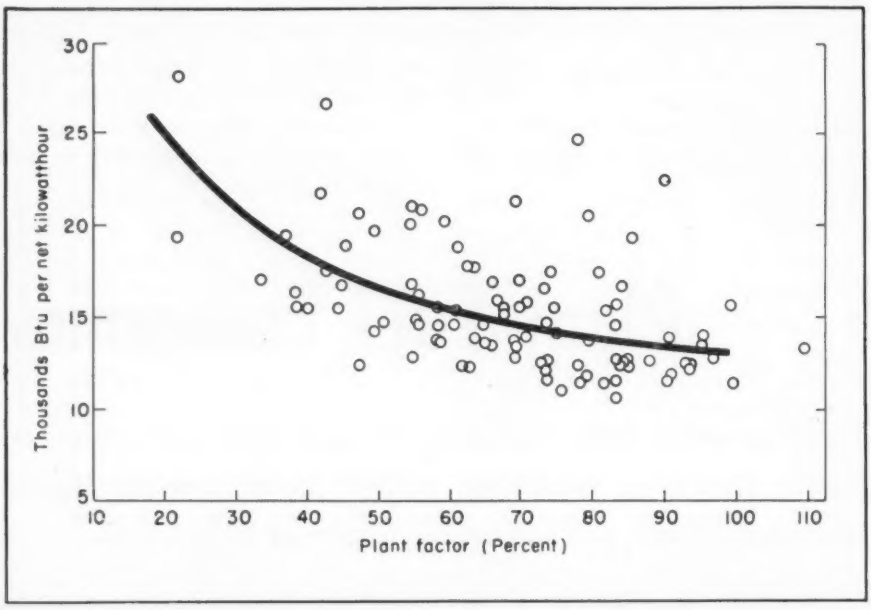


FIG 7—GOOD PLANT FACTOR, as would be expected, is conducive to bettered thermal economy

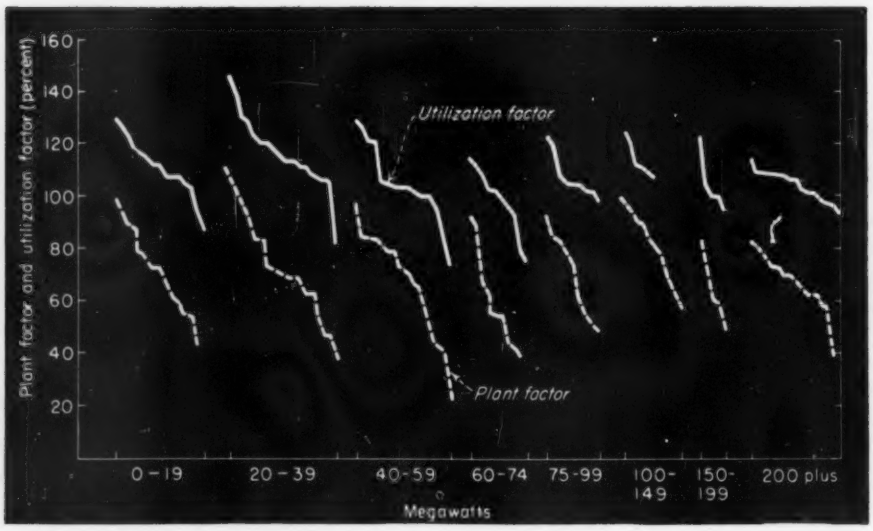


FIG 8—FEW PLANTS in 1947 were not subjected to a peak in excess of rating. Plant factors were in the 65 to 80% range

All plants in the dotted oval except those indicated as A and B have superposed units in them. It is manifest that the era of superposition was one in which added capacity could be obtained at modest cost and not one in which the compounding of stations was engaged in for the sake of superior thermal performance. The dilu tion arising from the retained low-pressure equipment precluded such an accomplishment.

Thermal performance is fully as much fixed by operating conditions as by the design objectives. Plant factor is a significant element in this respect as can be seen in Fig. 7. The better the plant factor, regardless of size or age of plant, the better the economy in use of heat units. The general average for 1947 operation was in the range from 50 to 85 percent plant factor and the corresponding Btu rate per net kilowatt-hour was from about 16,500 to 13,200 Btu. The lowest fell in the 10,000-11,000 Btu bracket. Again the spread for any particular plant factor is quite wide and affords ample latitude for improvement particularly where fuel cost is high. Of course a comparatively poor hydro year coupled with incessant consumption ran the plant factor up to higher levels and the Btu rate to lower levels than might otherwise have been expected.

Loading Favorable

This experience is also exemplified by Fig. 8. It made little difference in 1947 whether a plant was large, medium or small; all benefitted to a degree by the fairly favorable loading arising from limited capacity and unlimited consumption. Most striking is the high utilization factors across the chart (Fig. 8) and across the country. Few plants had peaks below the capacity rating and the great majority carried peaks 10 percent or more in excess of rating. It was indeed fortunate that capabilities exceeded the ratings by such comfortable margins.

Efficiency Utilized

Insofar as it could be carried out in the face of unrelenting demand for kilowatts and kilowatt-hours the stations favored by the lowest overall cost per kilowatt-hour were assigned the longest hours of operation, that is, given a chance to achieve best plant factor (Fig. 9). Normally this is a

primary function of interconnections and of the load dispatchers who administer them. Operation under the stress conditions of 1947 had to be focussed on optimum utilization of scant water power and scant generation of either kind but it is evident that interconnection operation did afford considerable opportunity to work most the plants capable of the best performance in Btu and in cents per kilowatt-hour.

Fig. 9 shows also that only 11 of the 102 plants had peak loadings below 95 percent of their rated capacity.

Coal has reached $10 per ton for some utilities; it may represent close to 40 cents per million Btu. Some elsewhere can, on the contrary, get 1000 cu.ft. (over a million Btu) for as low as 5 cents.

Fuel, Labor And Maintenance

Fuel is the largest component of production cost. Operating labor is next in magnitude. Mechanical equipment occasions most of maintenance expense

THE SAME TREND seen in Fig. 1 for production cost reappears quite naturally in Fig. 10 because the data are the same. Plants of 60-75 megawatts show the highest production cost and those in the 100-150 megawatt bracket the lowest production cost. Those in the 75-100 group follow the natural trend downward from the smallest to the largest stations.

Fuel represents varying percentages of the total production cost of generating a net kilowatt-hour. For the small plants, many of which are favored by cheap fuel, it may constitute only 25 percent. For the largest plants it may be up toward 80 percent or even higher. Perhaps 70 percent is not a bad figure for anyone prone to look for an all-inclusive average.

Wage Component

Wages and superintendence take a large chunk of the remainder, approximately 0.5-2 mill in the largest plants and only a fraction more in the moderate- and small-sized plants. It can perhaps be set down as 20 percent of the total cost of production as a broad overall average.

All the remainder goes for maintenance labor, water, supplies, lubrication, engineering, etc. The aggregate does not amount on the whole to much more than 10 percent of the total production cost.

Maintenance Costs

How the maintenance expense is incurred can be seen from Fig. 11. It is at once evident that the boilers and all their thermal accompaniments absorb the lion's share. It represents 1 mill or so per net kilowatt-hour in the largest plants and 1½ mills in the smaller ones. The newer high pressure boilers in the medium and large plants evidently require much less maintenance per unit output than the smaller plants which usually have low pressure boilers and, if not using gas or oil, have stoker furnaces.

Fuel handling is only occasionally a large item. Even then it may constitute 1/10 mill and be a 10 percent factor in maintenance costs. Frozen cars and clogged chutes are occasional factors in this expense.

The prime mover (turbine) occa-

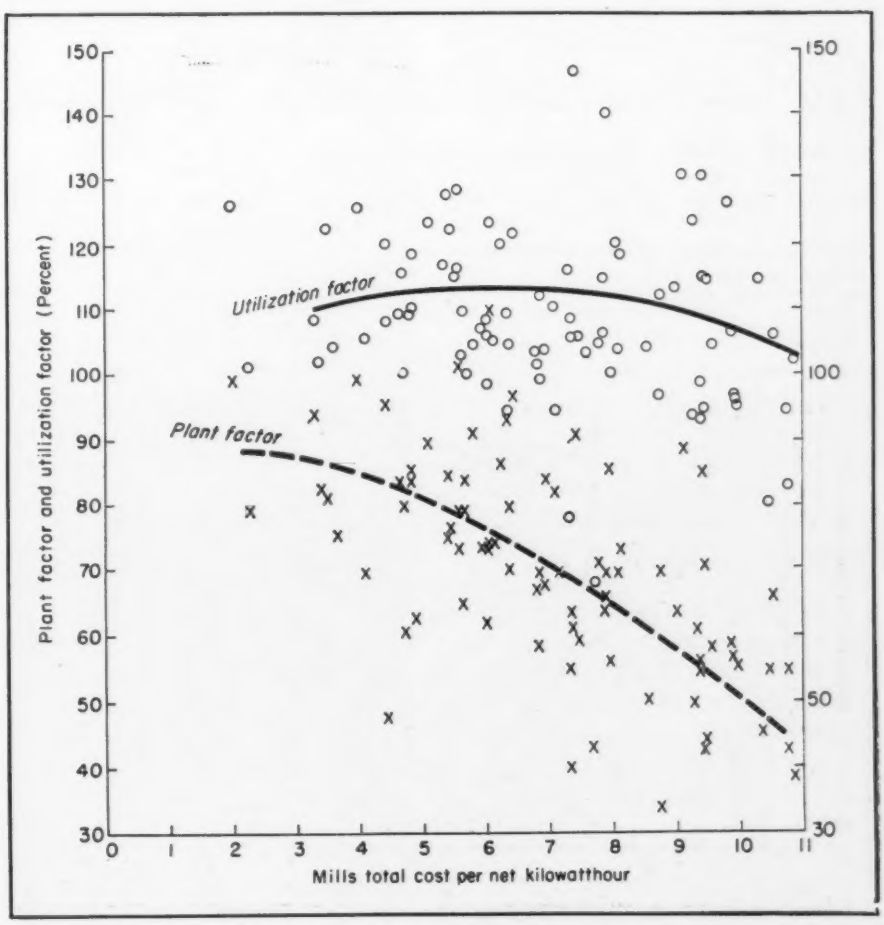


FIG 9—PLANTS FAVORED with lowest generation costs loaded more hours in year. All plants subjected to peak loads from 80-146% of rating, mostly above 100%

sions hardly more maintenance expense, in general, than fuel handling. The fact that it does not loom any larger in this analysis may be attributable to the necessity of keeping all units available as many hours in 1947 as possible and deferring the maintenance to a more propitious time.

Maintenance Cost

Maintenance of electrical equipment is smaller in general than that of the other items most of which are mechanical or structural in nature. On the average it amounts to less than 0.05 mill per net kilowatt-hour.

Maintenance of the power plant buildings and structures, while not negligible (no component of power generating cost is negligible today) does not entail as much as 0.1 mill per kilowatt-hour except in a few isolated cases.

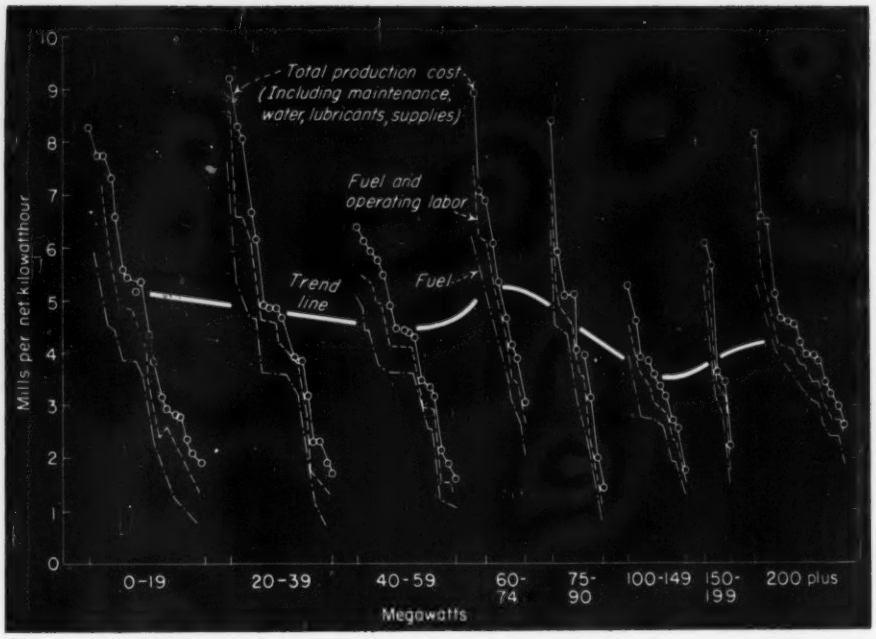


FIG 10—PRODUCTION COSTS vary over wide range but group averages fall mostly between 3.5 and 5.2 mills. Fuel is the greatest factor in all instances

Operating Staffs And Space Factors

Large plants require half as many employees per megawatt as small plants. Operation requires more men than maintenance. Large plants have advantage in unit space indexes

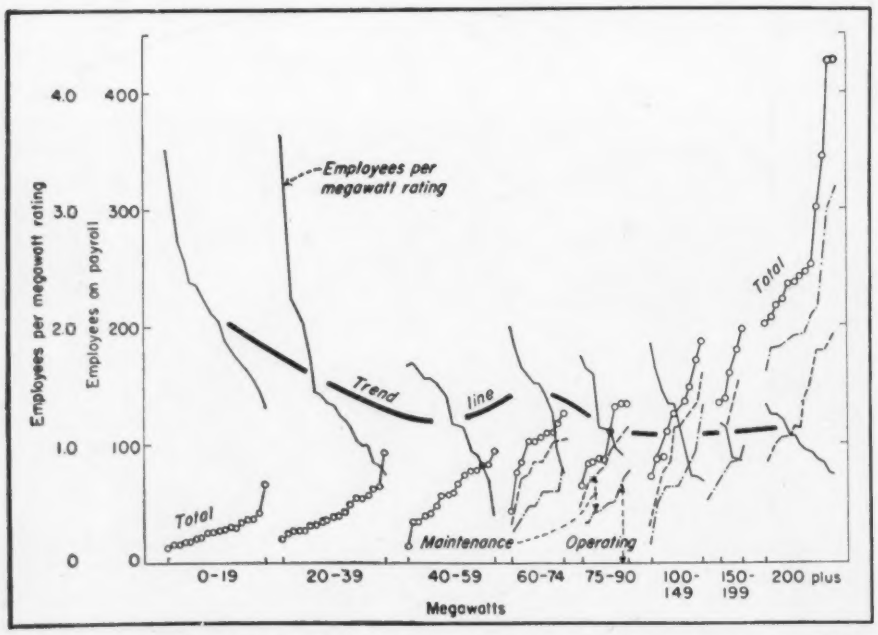


FIG 12—GENERAL AVERAGE is a fraction over one employee on the plant payroll for each Mw of rated capacity—more for small plants

LARGE STATIONS very definitely require fewer employees per megawatt of plant rating than the smaller stations. This is further an almost unbroken trend except for the peculiar hump that typifies the 60-75 megawatt group of stations in other respects (Fig. 12). The spread is quite pronounced, being just above 1 employee per megawatt for stations of 100 megawatts and upward and practically 2 for stations of less than 20 megawatts.

Reference to a corresponding analysis in the Fourth Steam Station Cost Survey (Electrical World, December 2, 1939, page 66) will show that the stations are being operated on the whole with slightly fewer employees than was the case 9 years ago. Some of this is definitely attributable to the establishment of new stations the design of which was aimed at minimizing the number of operating employees by advantageous configuration, location of control stations, etc.

Breakdown of the data shows that (at least for the plants above 60 megawatts) it takes roughly twice as many men in general to operate as to

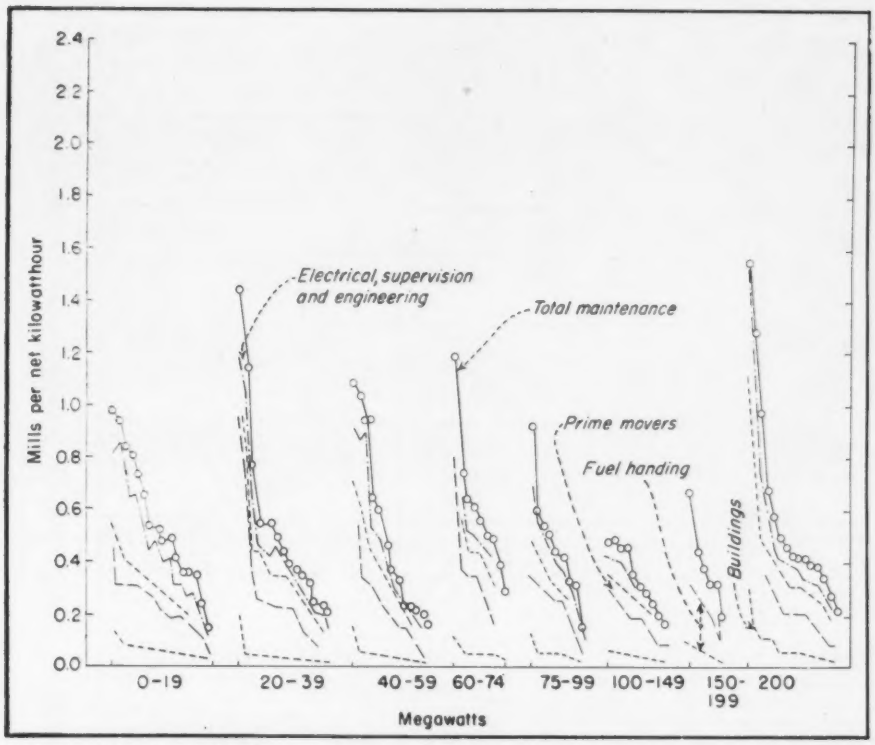


FIG 11—MAINTENANCE of boiler and associated mechanical-thermal equipment is largest factor in station maintenance. Building and electrical upkeep low

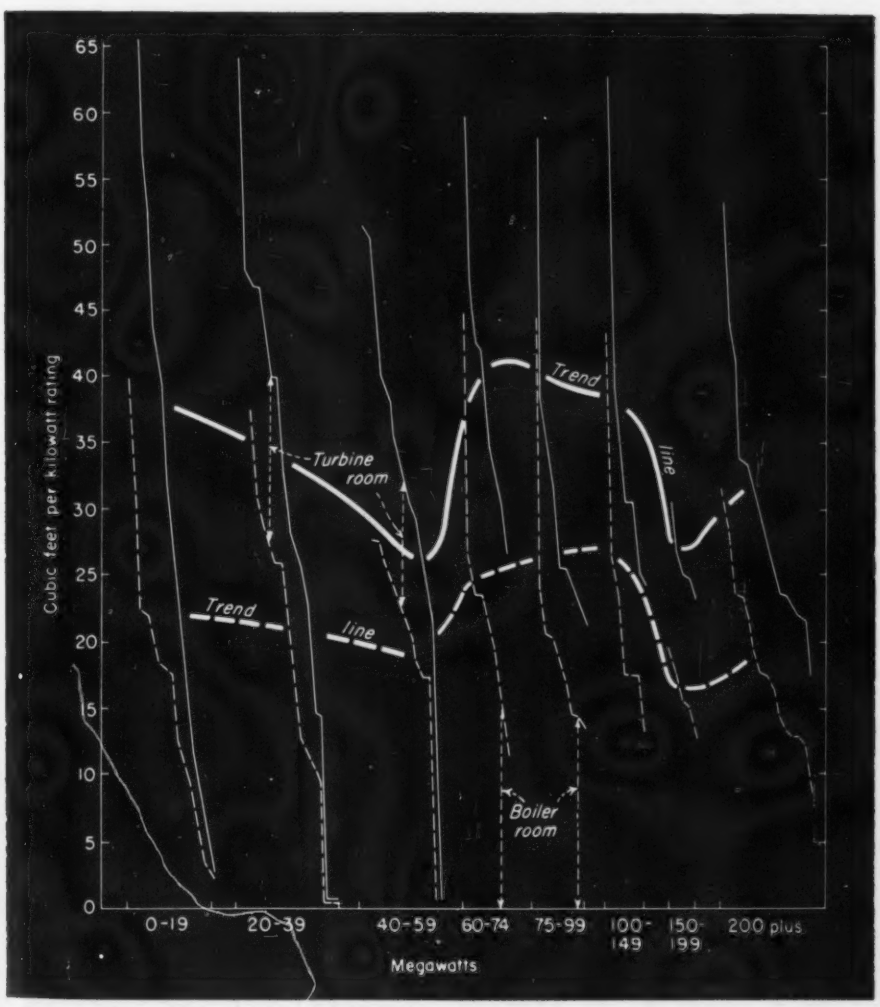


FIG 13—PLANTS of 40-60 and 150-200 Mw more economical of space than others. Factor for smaller plants held down by resort to outdoor boilers (occasionally a turbine also)

maintain the equipment. The very largest plants seem to reflect a greater proportion of employees assigned to maintenance than those of 200 megawatts and less rating.

Incidentally the figure reported by practically all utilities was the average number of employees on the power plant payroll over the year. Because of rotating shifts and concentration of as much maintenance as possible in advantageous periods any averaging of shift personnel would be difficult and inconclusive.

Between 60 and 150 megawatt ratings the stations have been so designed (Fig. 13) as to devote a greater volume of structure to both boiler and turbine rooms than for stations larger or smaller. Even if the dilution resulting in the case of the stations under 60 megawatts from outdoor installation of boiler (and occasionally the turbine outdoors) is compensated the very smallest stations do not exceed the space allotments in that 60-150 megawatt block. Structural costs are so much higher relatively than equipment costs that it is not surprising that every effort is being made to minimize the outlay for the building provided to house the working equipment.

TABULAR ANALYSIS

ON THE ENSUING PAGES are comprehensive details about the operating and cost experience of 113 representative power stations. The data have been arranged so that all the tabular information about a particular plant has been arranged in continuing columns across two facing pages. This has been done to facilitate determination of other indexes and comparisons than those derived for the curves on this and preceding pages.

One page 94, immediately following the last table will be found a tabulation and analysis of the prevalence of certain characteristics and of practices with regard to auxiliaries. In considering the inferences drawn from the tabulated information it should be remembered that the stations involved are of various vintages dating back to 1910. To help identify the relative freshness of any station the questionnaires for this 5th Survey raised the question of dates of initiation and latest expansion.

TABLE I—Steam Station Equipment Data And Production Costs (1947)

Station Number*	1	2	3	4	5	6	7	8	9	10	11	12	13	14(3R)	15	16
Total generator rating[1]	I	I	I	I	I	I	I	I	I	I	I[2]	I	I	I	I	I
Normal function[2]	(d)	(d)	(d)	(a)(c)	(a)	(a)	(a)	.....	(a)	(e)	(a)(c)(d)	(a)	(a)(c)(d)	(d)	(f)	(d)
Initial oper., oldest unit	'45–'50	'30–'34	'35–'39	'10–'19	'20–'29	'40–'44	'10–'19	'20–'29	'20–'29	'10–'19	'20–'29	'30–'34	'45–'50	'20–'29	'20–'29	'40–'44
latest unit	'45–'50	'30–'34	'35–'39	'20–'29	'45–'50	'45–'50	'40–'44	'20–'29	'35–'39	'20–'29	'40–'44	'35–'39	'45–'50	.....	'45–'50	'45–'50
No. of units, condensing	1	1	1	1	3	2	5	1	2	2	1	2	1	1	4	2
Superposed or non-condensing	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
Rating range, condensing (Mw)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Superposed or non-condensing (Mw)	.....	.....	.....	.....	.....	.....	.....	.....	I	.....	.....	.....	.....	.....	.....	.....
Boilers, number	2	1	1	4	3	2	5	2	7	4	3	4	1	2	6	3
Rating range (Mlbs/hr)	33.5	120	105	36	20–80	40–80	35–100	100–140	20–100	41–110	50–120	56.5–75	200	150	25–130	70–150
Steam pressure (s), (psi)	420	300	250	225	200; 625	200; 640	200–475	400	160; 850	210–225	225; 425	225	855	414	225; 650	250; 450
Temperature (F)	725	550	600	508	388; 825	385; 825	385–750	660	770	.....	490; 750	695–715	897	657	550–750	500; 750
Cooling water range (F)	55–98	44–95	50–98	34–78	44–100	43–82	56–95	59–89	32–85	60–100	34–85	54–95	56–94	32–93	50–95	57–90
Aver. vacuum (in.)	1.62	2.09	2.71	0.98	22	0.86; 1.62	1.80	2	29	1.5–4.0	1.29	1.64	1.39	1.53	1.5	2.45
Plant site area (acres)	0.8	51.5	15	20	1.75	21.8	1.88	30	.....	.....	5.9	156	9.3	64.19	3.2	40
In use (acres)	0.7	19.5	5	8	1.3	7.0	1.88	20	.....	.....	5.9	8.2	9.3	64.19	3.2	12
Fuel storage, coal (tons)	.....	.....	.....	16,896	.....	.....	.....	.....	1,600	.....	25,000	.....	.....	50,000	7,000	.....
Oil (bbls)	.....	.....	.....	.....	1,600	2,930	1,200	96,650	6,650	297	.....	2,850	55,000	.....	.....	2,300
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs)	16	15	12	20	28	21	19	30	27	18	30	25	34	41	37	26
Operation	11	12	9	12	18	16	14	22	18	11	16	15	20	26	25	18
Maintenance	4	2	2	3	8	3	4	7	5	6	2	6	13	11	5	5
Clerical, stores	1	1	1	1	2	2	1	1	.....	1	2	4	1	2	2	3
Fuel handling	.....	.....	.....	4	.....	.....	.....	.....	4	0	9	.....	0	2	3	.....
Guards	.....	.....	.....	0	.....	.....	.....	.....	.....	0	1	.....	0	.....	.....	.....
Station Details																
Stokers, pulverizers	—, —	—, —	—, —	√, —	—, —	—, —	—, —	—, —	—, √	.....	√, —	—, —	—, —	—, √	√, √	—, —
Air preheater, economizer	√, —	—, —	—, —	—, —	√, —	√, —	√, —	—, √	√, —	.....	—, √	√, —	√, —	√, —	√, —	—, —
Outdoor boiler, waterwalls	—, —	—, —	—, —	—, —	—, √	√, —	√, √	—, √	—, √	.....	—, √	—, √	√, √	—, √	—, √	—, —
Automatic combustion system	—	—	—	—	√	√	√	—	√	.....	√	√	√	—	√	√
Flyash collection; M(ech.), E(lec.)	—	—	—	M	—	.....	.....	—	M	.....	M	.....	M	—	M	.....
Stage bleeding, steam reheat	√, —	√, —	√, —	—, —	√, —	√, —	√, —	—, —	√, —	.....	√, —	√, —	√, —	√, —	√, —	√, —
Cooling tower, switchyard	√, √	—, √	√, √	—, √	√, √	—, √	√, √	—, √	—, √	.....	—, √	√, √	—, √	—, √	√, √	√, √
Duplicate pumps; Feed, Circ	√, —	√, —	√, —	√, —	√, √	√, √	√, √	√, √	√, √	.....	√, —	√, √	√, √	√, —	√, —	√, √
Generator cooler; Air, Hydrogen	√, —	—, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	.....	√, —	√, —	—, √	√, —	√, —	√, —
Fuel Consumption																
Coal (short tons)	.....	.....	.....	34,817	.....	.....	.....	.....	16,945	.....	74,639	.....	.....	8192.8	66,236	.....
Btu per lb	.....	.....	.....	10,331	.....	.....	.....	.....	10,000	.....	10,406	.....	.....	14,800	9,585	.....
Ash, moisture (%)	.....	.....	.....	15.61; 10.29	.....	.....	.....	.....	14; 14	.....	15.45; 9.31	.....	.....	1.2; 6.2	.....	.....
Cost delivered ($/ton)	.....	.....	.....	4.02	.....	.....	.....	.....	.....	.....	4.57	.....	.....	2.37	4.91	.....
Oil (barrels)	.....	.....	.....	.....	7,071	150	374	213,722	818	.....	.....	1,413	201,597	.....	.....	.....
Btu per gallon	.....	.....	.....	.....	140,000	.....	146,000	148,000	140,000	.....	.....	140,000	148,680	.....	.....	130,000
Cost delivered ($/bbl)	.....	.....	.....	.....	2.73	.....	.....	2.12	.....	.....	.....	2.20	2.07	.....	.....	2.57
Gas (M cu. ft.)	606,145	991,402	1,159,972	.....	711,836	867,199	917,359	.....	698,619	.....	.....	1,603,209	.....	1,228,900	68,627	2,085,263
Btu per cu. ft.	1,000	1,000	1,000	.....	997	1,000	1,065	.....	1,000	1,110	.....	915	.....	1,156	1,000	1,104
Cost delivered ($/M cu. ft.)	0.050	0.05	0.046	.....	0.109	0.1079	0.1264	.....	.....	0.1735	.....	0.10	.....	0.114	0.17	0.04
Output Data																
Total gross gen. (millions kwhr)	41.0	45	49.1	27.94	41.1	58.9	59.6	80.69	57	27	90.06	95.2	107.6	111	72.88	121.9
Total net gen. (millions kwhr)	38.5	43.9	47.1	27.15	36.6	55.11	53.8	76.5	52	25	86.13	89.5	101.2	109	64.03	112.2
Maximum 1-hr peak (Mw)	6.3	8	7.6	8	8.5	11.2	11.75	14	12	13.5	10	17.5	18.6	17	13	20.2
Hours operation 1947	8,320	7,711	8,415	6,570	8,758	8,760	8,756	7,624	.....	4,262	8,691	8,760	8,174	8,261	8,760	8,754
Operating Costs (Mills per NET kwhr)																
Fuel	0.79	1.13	1.14	5.156	2.65	1.70	2.23	5.9[2]	4.46	4.50	3.962	1.83	4.12	1.48	5.26	0.75
Wages and superintendence	0.82	0.97	0.69	1.984	1.22	0.94	0.89	1.2	0.98	1.36	0.868	0.64	0.71	0.78	1.34	0.58
Water, lubrication and supplies	0.17	0.19	0.13	0.109	0.25	0.16	0.14		0.28	0.23	0.119	0.31	0.12	0.05	0.41	0.24
Maintenance and repairs, total	0.23	0.49	0.35	0.977	0.94	0.15	0.52	0.538	0.84	1.18	0.498	0.36	0.41	0.51	0.65	0.36
Buildings and structures	0.01	0.16	0.05	0.056	0.06	0.02	0.05	0.054	0.03	0.10	0.060	0.07	0.03	0.005	.....	0.03
Boiler plant	0.11	0.09	0.14	0.268	0.25	0.02	0.12	0.235	0.28	1.60	0.158	0.10	0.15	0.008	0.53	0.10
Fuel Handling	.....	.....	.....	0.121	.....	.....	.....	0.013	0.10	0.04	0.146	.....	.....	0.005	.....	.....
Prime movers and aux	0.08	0.16	0.09	0.375	0.54	0.05	0.32	0.157	0.40	0.68	0.046	0.14	0.13	0.029	.....	0.13
Electrical equipment	.....	0.03	0.02	0.055	0.03	.....	0.01	0.004	0.02	0.01	0.046	0.01	0.05	0.0003	0.12	0.06
Supervision, engrg. and misc	0.03	0.05	0.05	0.102	0.06	0.02	0.02	0.075	0.01	1.82	0.042	0.04	.....	0.02	.....	0.04
Total oper. and maint. (excl. fuel)	1.22	1.65	1.17	3.070	2.51	1.25	1.55	1.738	2.11	2.77	1.485	1.31	1.24	1.34	2.40	1.18
Total production (incl. fuel)	2.01	2.78	2.31	8.226	5.16	2.95	3.78	7.65	6.57	7.27	5.447	3.14	5.36	2.82	7.66	1.93

(*Continued on page* 82)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)

Station Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Investment Data (Dollars per kw)																
(310) Land	1.18	0.58	0.23	0.865	0.82	0.29	1.15	4.75	.....	4.88	3.543	1.02	4.21	1.95	1.57	0.16
(311) Structures, improvements	19.57	51.66	9.84	19.484	7.91	32.46	13.69	53.00	.....	20.90	26.552	26.94	66.97	30.39	35.14	27.46
(312) Boiler plant equipment	35.05	27.20	12.73	33.789	42.42	32.79	42.00	70.00	.....	.....	54.34	27.44	53.01	55.00	75.60	34.95
(314) Turbogenerator unit	48.99	15.50	15.82	29.134	59.39	44.89	44.70	56.75	.....	41.5	50.111	35.66	38.70	27.74	54.86	45.76
(315) Accessory elec. equipt	8.34	5.18	5.71	4.257	19.71	21.12	8.80	12.40	.....	.....	11.859	5.76	11.06	8.41	9.88	11.45
(316) Misc. plant equipt	3.21	0.79	0.92	0.838	2.90	1.88	0.86	1.17	.....	.....	7.940	0.98	3.52	3.83	3.20	0.98
Total station	116.34	100.91	45.25	88.367	133.15	133.43	111.20	198.00	.....	67.4	149.345	97.80	177.47	127.32	180.25	120.76
Outdoor switching	7.72	5.64	12.73	1.593	9.73	13.51	3.37	12.50	.....	.....	2.215	.....	12.79	15.65	5.52	.....
Total sta. and switchyard	124.06	106.55	57.98	89.960	42.88	146.94	114.57	210.50	115.11	.....	151.560	97.80	190.26	142.97	185.77	120.76
Building	.....	.....	.....	13.562	.....	.....	.....	45.00	.....	.....	20.676	.....	.....	29.20	.....	.....
Condensing supply works	.....	.....	.....	3.636	.....	.....	.....	4.78	.....	.....	17.257	.....	.....	0.89	.....	.....
Fuel handling	.....	.....	.....	2.700	.....	.....	.....	2.68	.....	.....	5.542	.....	.....	4.89	.....	.....
Ash handling	.....	.....	.....	0.676	.....	.....	.....	.....	.....	.....	2.062	.....	.....	2.17	.....	.....
Draft system	.....	.....	.....	4.013	.....	.....	.....	3.34	.....	.....	4.071	.....	.....	4.75	.....	.....
Feedwater system	.....	.....	.....	2.708	.....	.....	.....	4.52	.....	.....	4.591	.....	.....	3.07	.....	.....
Piping system	.....	.....	.....	7.589	.....	.....	.....	23.70	.....	.....	11.338	.....	.....	8.60	.....	.....
Turbogenerators	.....	.....	.....	18.862	.....	.....	.....	33.20	.....	.....	24.705	.....	.....	20.61	.....	.....
Turbine foundations	.....	.....	.....	.....	.....	.....	.....	1.84	.....	.....	.....	.....	.....	0.61	.....	.....
Condensers	.....	.....	.....	5.183	.....	.....	.....	7.25	.....	.....	7.809	.....	.....	3.84	.....	.....
Switchgear, station wiring	.....	.....	.....	1.500	.....	.....	.....	12.40	.....	.....	5.824	.....	.....	.....	.....	.....
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	2.42	2.37	1.38	1.233	4.68	4.00	3.52	5.17	4.22	5.66	2.30	2.46	4.23	2.628	6.25	5.82
Production charges (Table I)	2.01	2.78	2.31	8.226	5.16	2.95	3.78	7.65	6.57	7.26	5.447	3.14	4.95	2.797	7.66	1.93
Total cost	4.43	5.15	3.69	9.459	9.82	6.95	7.30	12.82	10.79	12.92	7.747	5.60	9.18	5.425	13.91	4.75
Station Performance 1947																
Billions Btu used	606.145	991	1,160	719.4	752.6	868.09	1,011.3	1,331	1,043	686.7	1,544	1,478	1,259	1,664	1,339	2,309
Fuel cost, cents per million Btu	5.0	4.99	4.64	19.45	12.9	10.81	11.88	33.99	22.24	17.35	2.213	11.08	33.2	9.06	25	4.06
Btu per NET kwhr send-out	15,740	22,430	24,497	26,416	20,420	15,763	18,835	17,390	20,074	28,200	.....	16,460	12,437	15,297	20,916	20,545
Btu per GROSS kwhr generated	14,790	22,000	23,610	25,674	18,320	14,720	16,970	.....	18,294	25,300	.....	15,510	11,700	14,956	18,374	18,930
Aver. boiler efficiency (%)	.....	.....	.....	71.36	82.9	86.1	80	78	.....	.....	.....	84	86.7	86.2	.....	72.6
Station thermal eff., NET, (%)	23.1	15.5	14.4	12.92	18.6	23.2	20.1	20.7	.....	.....	.....	22	27.4	22.3	16.3	18
Employees per 1000 kw per day	3.2	2.31	1.6	2.17	3.5	2.1	1.73	2.4	2.13	1.28	1.86	1.668	2.26	2.7	1.76	1.487
Plant factor, annual (%)	98.5	89.8	77.8	42.52	58.6	67.3	61.9	73.5	54	22	67	73.2	87.8	74.7	55.5	79.5
Utilization factor, annual (%)	126	123.1	101.2	114	106.2	112.0	106.9	112	94	96.5	67	116.8	130	117	86.7	115.3
Station Space Factors per kw																
Boiler room (cu. ft /kw)	12.9	18.0	8.9	40	11.4	22.5	20.5	76.5	.....	.....	31.	18.3	2.27	22.2	57.73	17.5
Turbine room (cu. ft /kw)	3.6	10.8	0.57	37	9.3	29.6	18.6	38.8	.....	.....	26.	14.5	1.71	9.5	34.18	25.0
Switchhouse (cu. ft /kw)	.....	1.86	.....	0.5	.....	.....	3.0	22.7	.....	.....	2.1	1.44	0.53	0.28	.....	0.7
Office and employee (cu. ft /kw)	1.8	0.63	0.115	0.1	0.74	2.5	0.34	1.7	.....	.....	1.2	0.80	1.13	1.4	1.63	0.7
Building, ground area (sq. ft /kw)	0.68	0.89	0.54	3.8	0.665	1.18	2.41	2.08	.....	.....	1.00	1.13	5.64	.....	1.39	1.07
Switchyard (sq. ft /kw)	0.3	0.28	1.29	0.66	0.90	3.04	0.90	4.4	.....	.....	0.48	0.67	2.44	5.6	0.23	3.1
Fuel storage area (sq. ft /kw)	.....	.....	.....	8	.....	.....	0.29	7	.....	.....	2.67	.....	2.25	.....	2.33	.....
Coal storage (tons/kw)	.....	.....	.....	2.26	.....	.....	.....	.....	.....	.....	1.41	.....	.....	3.33	0.5	.....

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Partly engine-driven units. (4) Coke.

(*Continued on page* 83)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Continued)

Station Number*	17(4)	18(1)	19	20	21	22	23	24	25	26	27	28	(29)	30	(31)	32
Total generator rating[1]	I	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II
Normal function[2]	(a)	(d)(f)	(d)	(a, b, d)	(a)	(b)(f)	.....	(d)	(a)	(d)(f)	(a)	(a)	.....	(c)	(a)(b)(c)(d)	(a)
Initial oper., oldest unit	'35–'39	'35–'39	'35–'39	'40–'44	'20–'29	'10–'20	'40–'44	'40–'44	'45–'50	'20–'29	'20–'29	'20–'30	'45–'50	'45–'50	'10–'19	'20–'29
latest unit	'35–'39	'45–'50	'35–'39	'40–'44	'20–'29	'40–'45	'40–'44	'40–'44	'45–'50	'40–'44	'20–'29	'30–'34	'45–'50	'45–'50	'40–'44	'40–'44
No. of units, condensing	1	1	1	2	2	6	1	1	1	3	3	3	1	1	4	4
Superposed or non-condensing	.....	1[3]	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....	.....
Rating range, condensing (Mw)	1	.....	II	I	I	I	II	II	II	.....	I	I	II	II	I-II	I
Sup'p'd or non-cond. (Mw)	.....	[3]	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....	.....
Boilers, number	1	3	2	3	5	7	1	2	1	8	4	5	2	1	6	6
Rating range (Mlbs/hr)	200	200	100–125	120	65	30–80	350	225	275	30–60	100–150	60–125	200	325	10–300	75–200
Steam pressure (s), (psi)	400	475	600	650	325	200; 650	650	825	900	225; 450	355	440	671	850	205; 856	325
Temperature (F)	750	760	750	825	675	600; 850	830	900	900	520; 750	720	700	825	900	550; 894	675
Cooling water range (F)	40–65	40–95	32–80	65–85	33–91	31–61	59–94	32–90	33–88	.....	32–80	32–85	33.54–73.69	64–94	63–89	60–92
Aver. vacuum (in.)	0.72	27.5	1.2	2	28.27	28.7	2.11	29.15	0.89	28	27.98	28	1.211	1.92	1.87	2.37
Plant site area (acres)	33	1,121	7.1	.....	41.86	1	109	6	.....	3.5	21.5	.....	23.06	96.6	3.2	25
In use (acres)	12	1,121	7.1	4	41.86	1	66	5	.....	1.1	12.0	.....	13.3	12.3	3.2	16
Fuel storage, coal (tons)	10,000	.....	20,000	.....	30,000	5,000	.....	15,000	25,000	10,000	54,000	10,000	60,000	.....	.....	.....
Oil (bbls)	.....	31,600	14,285	65,000	20	.....	10,000	595	200	4,500	2,440	.....	365[5]	20,000	10,000	7,150
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	38	24	55	20	40	31	25	57	34	93	62	64	41	26	50	36
Operation	26 5	18	42	12	19	22	15	37	21	.....	28	28	32	18	23	23
Maintenance	6	6	5	8	15	7	8	13	7	.....	15	18	8	6	26	8
Clerical, stores	1 5	.....	.....	.....	2	.....	2	2	1	.....	4	5	3	2	1	5
Fuel handling	4	.....	7	.....	3	1	0	3	5	.....	15	11	4	0	0	.....
Guards	0	.....	.....	.....	1	1	0	2	.....	.....	0	2	0	0	0	.....
Station Details																
Stokers, pulverizers	√, —	.....	—, √	—, —	√, —	√, —	—, —	—, √	—, √	√, √	—, √	√, —	√, —	—, —	—, —	—, —
Air preheater, economizer	—, —	√, —	√, —	√, —	√, √	—, —	√, —	√, √	√, √	√, √	√, √	—, √	√, √	√, —	√, √	√, —
Outdoor boiler, waterwalls	½, √	√, √	—, √	—, √	—, —	—, √	√, √	—, √	—, √	—, √	—, √	—, √	—, √	√, √	√, √	—, √
Automatic combustion system	.....	.....	√	√	√	√	.....	√	√	—, —	.....	√	√	√	√	√
Flyash collection; M(ech.), E(lec.)	M	.....	E	M	.....	M	.....	E	M	M	.....	—	M	—	M	.....
Stage bleeding, steam reheat	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	—, —	√, —	√, —	√, —	√, —	√, —	√, —
Cooling tower, switchyard	—, √	√, —	—, √	√, √	—, √	—, —	√, √	—, —	—, √	√, —	—, √	√, —	—, √	√, √	—, √	√, √
Duplicate pumps; Feed, Circ	√, —	√, √	√, —	√, √	√, —	√, √	√, —	√, √	√, —	√, √	√, √	√, √	√, —	√, —	√, —	√, √
Generator cooler; Air, Hydrogen	√, —	√, √	√, —	√, —	√, —	√, —	—, √	—, √	—, √	√, —	√, —	√, —	—, √	—, √	√, √	√, —
Fuel Consumption																
Coal (short tons)	34,457	.....	44,359	.....	75,464	52,574	.....	68,030	72,880	50,000	57,454	90,170	148,730	.....	.....	.....
Btu per lb	12,646	.....	14,500	.....	11,555	13,845	.....	13,108	11,449	13,800	11,460	11,189	11,442	.....	.....	.....
Ash, moisture (%)	7.53; 6.59	.....	7; 5	.....	15.1; 8.2	6.7; 4.4	.....	8.17; 3.91	8.9; 10.2	11; 3.4	12; 9	15.12	10.46; 11.53	.....	.....	.....
Cost delivered ($/ton)	5.09	.....	10,919	.....	6.02	10.75	.....	7.03	6.20	10.00	6.40	5.00	4.27	.....	.....	.....
Oil (barrels)	.....	200,000	69,300	104,928	50	.....	814	2,796	960	.....	2,911	.....	.....	2,165	368,672	380
Btu per gallon	.....	142,000	152,900	153,000	135,000	.....	148,500	139,562	141,000	.....	140,000	.....	.....	152,000	149,100	137,950
Cost delivered ($/bbl)	.....	3.65	2.32	1.51	5.50	.....	1.293	4.02	.....	3.40	2.268	.....	.....	3.05	2.03	1.87
Gas (M cu. ft.)	.....	4,300,000	.....	1,129,546	.....	.....	3,215,201	.....	.....	.....	1,623,466	.....	.....	1,260,935	.....	3,438,040
Btu per cu. ft	.....	1,004	.....	1,100	.....	.....	1,050	.....	.....	.....	1,010	.....	.....	983	.....	908
Cost delivered ($/M cu. ft.)	.....	0.155	.....	0.268	.....	.....	0.0345	.....	.....	.....	0.146	.....	.....	0.0865	.....	0.067
Output Data																
Total gross gen. (millions kwhr)	55.53	149	130.4	137.4	88.46	79.75	266.5	159.19	146	55	183.6	111	269.8	109.9	188.8	191.2
Total net gen. (millions kwhr)	51.31	138	124.3	128.9	84.38	75.37	250.6	145.89	138	52	174.4	103	258.3	102.8	178.9	176.8
Maximum 1-hr peak (Mw)	18.5	28	22.9	21	24	21,500	32.2	27.67	29	15.4	33.8	24	37	35	38.6	41.4
Hours operation 1947	4,416	8,736	4,273	8,760	8,760	8,760	8,495.9	8,478	6,693.7	8,640	8,760	8,760	8,215	4,175	8,225	8,760
Operating Costs (Mills per NET kwhr)																
Fuel	3.41	3.1	5.2	3.576	5.382	7.7	4.54	3.36	3.356	8.16	3.507	4.57	2.46	1.15	4.19	1.30
Wages and superintendence	1.37	0.54	0.990	1.054	1.253	0.81	2.001	1.0	0.479	2.42	0.713	0.99	0.44	0.259	0.51	0.40
Water, lubrication and supplies	0.09	0.4	0.062	0.077	0.241	0.11	0.293	0.09	.....	.....	0.105	0.08	0.09	0.155	0.10	0.34
Maintenance and repairs, total	0.74	0.32	0.370	0.133	1.140	0.76	1.465	0.49	0.097	.....	0.422	0.54	0.23	0.148	0.53	0.25
Buildings and structures	0.09	0.01	0.040	0.026	0.0421	0.025	0.216	0.04	.....	.....	0.017	0.03	0.02	0.0078	.....	0.04
Boiler plant	0.36	0.25	0.230	0.178	0.740	0.375	0.718	0.20	.....	.....	0.091	0.20	0.07	0.091	0.25	0.04
Fuel handling	0.09	0.02	}	.....	0.091	0.039	0.028	0.13	.....	.....	0.146	0.20	0.06	.....	.....	.....
Prime movers and aux	0.11	0.01	} 0.060	.....	0.182	0.231	0.226	0.10	.....	.....	0.073	0.02	0.04	0.0304	0.17	0.13
Electrical equipment	0.01	0.01	}	0.295	0.027	0.069	0.037	0.04	.....	.....	0.025	0.09	0.01	0.015	0.09	.....
Supervision, engrg. and misc	0.08	0.02	0.040	0.037	0.054	0.024	0.240	0.01	.....	.....	0.070	.....	0.03	0.041	0.02	0.04
Total oper. and maint. (excl. fuel)	2.20	1.2	1.422	1.264	2.634	1.53	3.759	1.58	0.576	.....	1.240	1.61	0.76	0.562	0.61	0.99
Total production (incl. fuel)	5.61	4.3	6.662	4.840	8.016	9.23[4]	8.299	4.94	3.932	.....	4.747	6.18	3.22	1.712	4.80	2.29

(*Continued on page 84*)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Continued)

Station Number	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Investment Data (Dollars per kw)																
(310) Land	1.66	5.25	0.60	.....	0.86	0.92	0.26	6.44	1.58	.....	1.67	2.14	0.56	.....	2.93	0.42
(311) Structures, improvements	14.35	22.50	22.02	.....	31.91	23.61	25.27	28.52	35.44	.....	35.58	19.22	55.90	.....	30.34	12.63
(312) Boiler plant equipment	19.30	72.25	55.34	.....	49.85	30.48	27.42	64.39	50.32	.....	51.53	31.40	50.43	.....	28.49	22.19
(314) Turbogenerator units	22.86	37.75	29.86	.....	28.33	37.10	23.33	33.43	32.65	.....	46.07	34.80	27.14	.....	35.21	36.51
(315) Accessory elec. equipt	3.53	18.00	10.59	.....	10.19	14.45	7.67	11.93	6.12	.....	9.31	11.45	12.17	.....	15.47	10.66
(316) Misc. plant equipt	0.63	0.75	0.82	.....	0.58	0.24	2.74	0.60	1.54	.....	2.34	0.41	4.52	.....	1.56	0.96
Total station	62.33	156.50	119.23	.....	121.72	106.80	86.69	145.31	127.65	.....	146.50	99.42	150.72	.....	114.01	83.37
Outdoor switching	2.73	.....	.....	.....	21.60	.....	4.50	.....	6.06	.....	10.56	.....	16.27	.....	4.46	5.58
Total sta. and switchyard	65.06	156.50	.....	.....	143.32	106.80	91.19	145.31	133.71	.....	157.06	99.42	166.99	.....	118.46	88.95
Building	9.64	20.00	19.47	.....	29.40	.....	11.02	17.60	.....	.....	.....	.....	.....	.....	.....	.....
Condensing supply works	2.11	7.50	1.39	.....	.....	.....	8.97	4.69	.....	.....	.....	.....	.....	.....	.....	.....
Fuel handling	3.47	6.50	31.12	.....	5.94	.....	3.22	6.16	.....	.....	.....	.....	.....	.....	.....	.....
Ash handling	.....	3.12	.....	.....	2.66	.....	0.51	1.23	.....	.....	.....	.....	.....	.....	.....	.....
Draft system	1.42	7.75	0.59	.....	5.29	.....	2.45	1.72	.....	.....	.....	.....	.....	.....	.....	.....
Feedwater system	2.13	10.00	3.28	.....	2.71	.....	4.10	9.06	.....	.....	.....	.....	.....	.....	.....	.....
Piping system	4.57	27.00	5.61	.....	7.63	.....	5.85	14.94	.....	.....	.....	.....	.....	.....	.....	.....
Turbogenerators	19.49	30.00	28.29	.....	20.98	.....	22.45	33.43	.....	.....	.....	.....	.....	.....	.....	.....
Turbine foundations	0.62	0.80	2.48	.....	0.77	.....	0.88	0.27	.....	.....	.....	.....	.....	.....	.....	.....
Condensers	2.75	4.50	2.92	.....	6.58	.....	4.60	2.99	.....	.....	.....	.....	.....	.....	.....	.....
Switchgear, station wiring	3.53	18.00	9.85	.....	10.19	.....	5.57	11.93	.....	.....	.....	.....	.....	.....	.....	.....
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	3.42	3.4	2.877	1.317	5.75	5.21	1.63	3.29	3.64	.....	4.059	4.35	2.90	.....	3.32	2.64
Production charges (Table I)	5.61	4.6	6.622	4.840	8.016	9.23	8.229	4.94	3.932	9.78	4.747	6.18	3.22	1.712	4.80	2.29
Total cost	9.03	8.0	9.499	6.157	13.766	14.44	9.859	8 23	7.37	.....	8.806	10.53	6.12	.....	8.12	4.93
Station Performance 1947																
Billions Btu used	871.5	5,500	1,736	1,907	1,744	1,454	3,400	1,800	1,458	.....	2,973.6	2,012	3,389	1,292	2,309	3,122
Fuel cost, cents per million Btu	19.02	26	37.24	24.167	26	39.86	3.35	27	27.65	.....	20.6	23.4	18.75	9.15	32.5	7.37
Btu per NET kwhr send-out	15,983	12,100	13,964	14,800	20,673	19,314	13,567	12,337	12,136	.....	17,010	21,179	13,124	12,576	12,903	17,690
Btu per GROSS kwhr generated	15,693	11,390	13,310	13,886	19,715	18,230	12,760	11,306	11,460	.....	16,190	18,126	12,563	11,759	12,225	16,320
Aver. boiler efficiency (%)	71.3	83	82.3	.....	70.6	66.8	82.7	86	86.62	.....	85.55	78	83.97	85.97	87.4	80.0
Station thermal eff., NET, (%)	21.75	30	24.34	23.1	16.5	17.5	39.8	27.6	28.12	.....	20.01	19	26.01	29.03	26.4	20.9
Employees per 1000 kw per day	2.03	1.2	2.75	1.0	1.78	1.26	1.0	2.28	1.36	.....	2.07	2.13	1.37	0.84	1.49	1.03
Plant factor, annual (%)	33.81	85	70.9	73.6	47.25	37.2	95	72.9	62.9	.....	69.9	54	109.5	83	68.5	62.4
Utilization factor, annual (%)	98.5	140	114.5	105.0	106.6	114	128	118	116	.....	112.7	80	123.3	111	120	118.1
Station Space Factors per kw																
Boiler room (cu. ft./kw)	3.19	10.0	37.22	.....	31	26	.....	26.05	20.7	.....	28.92	.....	27.1	0	9.41	9.48
Turbine room (cu. ft./kw)	8.56	4.7	26.99	.....	18	19	.....	21.34	12.17	.....	17.68	.....	12.5	0.5	4.93	17.15
Switchhouse (cu. ft./kw)	.....	1.6	0.77	.....	2.7	.....	.....	3.74	.....	.....	5.78	.....	.....	0.42	2.20	2.16
Office and employee (cu. ft./kw)	0.19	0.5	1.38	.....	0.35	0.17	.....	1.02	0.53	.....	1.12	.....	0.63	2.2	0.61	0.54
Building, ground area (sq. ft./kw)	0.50	24.5	1.70	.....	0.8	0.88	.....	4,148	.....	.....	0.78	.....	0.925	0.35	0.80	0.70
Switchyard (sq. ft./kw)	0.17	0	0.26	.....	5	.....	.....	.....	.....	.....	0.61	.....	0.308	0.47	0.33	2.16
Fuel storage area (sq. ft./kw)	24.2	0	2.66	.....	4	0.8	.....	4,148	.....	.....	10.00	.....	3.50	1.3	0.46	.....
Coal storage (tons/kw)	0.53	0	1.00	.....	1.33	0.2	.....	0.48	1	.....	1.81	0.33	1.82	.....	.....	.....

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Back pressure. (4) Steam sales credit 0.15. (5) For heating and car thawing.

(*Continued on page* 85)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Continued)

Station Number*	33	34	35	(36)(16)	37	38	39	40	41	42(12)	43	44(20)	45	46	47	48
Total generator rating[1]	II	II	II	II	II	III	III	III	III	III	III	III	III	III	III	III
Normal function[2]	(c)(d)	.....	(a)(c)(d)	(a)	(a)	(a)(b)(c)	(a)	(a)	(a)	(a)	(a)	(a)	(d)	(a)	(c)(d)	(a)
Initial oper., oldest unit	'45–'50	'40–'44	'45–'50	'10–'19	'20–'29	'10–'19	'40–'44	'35–'39	'45–'50	'20–'29	'10–'19	'20–'29	'30–'34	'20–'29	'40–'44	'40–'44
latest unit	'45–'50	'40–'44	'45–'50	'35–'39	'40–'44	'45–'50	'45–'50	'40–'44	'45–'50	'35–'39	'40–'44	'20–'29	'40–'44	'40–'44	'40–'44	'40–'44
No. of units, condensing	1	1	1	5	4	5	2	2	1	4	4	2	2	4	1	2
Superposed or non-condensing	.....	.....	0	.....	0	0	.....	.....	0	.....	.....	.....	.....	.....	.....	.....
Rating range, condensing (Mw)	II	II	II	I	I–II	I	II	II	III	I	I, II	II	II	I, II	III	II
Sup'p'd or non-cond. (Mw)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Boilers, number	1	2	2	7	8	8	3	3	1	8	10	3	3	6	1	4
Rating range (Mlbs/hr)	420	200	250	45–100	39–125	35–120	.....	110–220	400	85–100	43–300	185	200	70–200	525	150
Steam pressure (s), (psi)	925	850	851	200; 400	200; 300	200; 425	650	675	1,250	250	185; 940	450	400	225; 975	860	650
Temperature (F)	850	900	884	450; 750	531; 656	550–800	825	825	950	650	550–900	750	750	500–825	900	825
Cooling water range (F)	48–90	57–74	66–90	45–87	54–96	33–85	.....	37.0–73.3	60–89	38–100	33–81	35–82	48–100	35–84	32–90	32–90
Aver. vacuum (in.)	28.63	1.7	1.53	29	2.36	28.58	28	1.23	1.5	27.8	27.56	1.5	1.31	1.75	28.56	1.01
Plant site area (acres)	25.116	3.19	20.6	4.74	21.1	13	.....	180.48	36.7	60	34	67	150[3]	3½	196	207.4
In use (acres)	25.116	1.08	20.6	4.74	19.	10	.....	15	.....	30	34	8	150	3½	28	.....
Fuel storage, coal (tons)	.....	15,940	.....	10,000	.....	12,000	.....	50,000	.....	.....	35,000	.....	.....	18,000	110,000	52,567
Oil (bbls)	6,000	.....	110,000	15,000	.....	.....	42,000	310	25,000	10,000	.....	10,000	65,727	.....	470	494
Gas (M cu. ft.)	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	27	31	39	68	55	57	15	66	34	41	73	78	48	35	81	40
Operation	26	16	23	43	28	30	12	37	22	22	47	57	25	20	31	24
Maintenance	1	9	15	11	21	21	2	19	6	16	21	20	21	8	23	9
Clerical, stores	.....	1	1	6	6	1	.....	3	3	3	3	1	2	1	8	3
Fuel handling	.....	.....	.....	8	.....	5	1	7	.....	0	2	.....	.....	6	16	4
Guards	.....	3	.....	0	.....	0	.....	0	3	0	0	.....	.....	0	3	0
Station Details																
Stokers, pulverizers	—, —	—, —	—, —	—, √	—, —	√, √	—, —	—, √	—, —	.....	√, √	—, —	—, —	√, √	—, √	—, √
Air preheater, economizer	√, √	√, —	√, —	√, √	—, —	√, √	√, —	√, √	√, —	.....	√, √	√, √	√, —	√, √	√, —	√, —
Outdoor boiler, waterwalls	—, √	—, √	√, √	—, √	—, √	—, √	—, √	—, √	√, √	.....	—, √	√, √	—, √	—, √	—, √	—, √
Automatic combustion system	√	√	√	√	—	√	√	√	√	.....	√	√	—	√	√	√
Flyash collection; M(ech.), E(lec.)	—	.....	M	—	—	M	.....	M	—	.....	M	.....	—	M	M	M
Stage bleeding, steam reheat	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —
Cooling tower, switchyard	—, √	—, —	—, √	—, —	√, √	—, √	√, √	—, —	—, √	√, √	—, √	—, √	√, √	—, √	—, √	—, √
Duplicate pumps; Feed, Circ	√, √	√, √	√, √	√, √	√, —	√, √	√, —	√, —	√, √	√, —	√, √	√, √	√, —	√, —	√, √	√, √
Generator cooler; Air, Hydrogen	—, √	√, √	—, √	√, —	√, —	√, —	√, —	√, —	—, √	√, —	√, √	√, —	√, —	√, —	—, √	√, —
Fuel Consumption																
Coal (short tons)	.....	.....	.....	.....	.....	114,483	.....	154,231	.....	.....	178,856	.....	.....	141,834	199,682	193,519
Btu per lb	.....	.....	.....	.....	.....	11,018	.....	13,467	.....	.....	12,702	.....	.....	11,178	13,276	11,468
Ash, moisture (%)	.....	.....	.....	.....	.....	11; 12	.....	8.99; 4.76	.....	.....	10.5; 4.0	.....	.....	8; 12.2	8.75; 5.03	11.49; 9.38
Cost delivered ($/ton)	.....	.....	.....	.....	.....	5.94	.....	7.559	.....	.....	5.67	.....	.....	5.80	7.86	4.58
Oil (barrels)	64	84,613	431,526	423,664	.....	.....	2,000/day	2,240	.....	.....	.....	.....	512	5,839.7	6,003	1,537
Btu per gallon	147,876	151,643	149,450	150,246	.....	.....	153,000	145,000	.....	.....	.....	146,446	141,161	145,961	138,000	137,265
Cost delivered ($/bbl)	2.48	1.775	1.98	2.17	.....	.....	2.35	5.40	.....	2.50	.....	.....	1.49	.....	3.33	3.67
Gas (M cu. ft.)	892,287	570,339	.....	.....	4,906,640	.....	.....	.....	.....	6,492,000	.....	.....	4,533,700	5,868.14	.....	.....
Btu per cu. ft	1,132	1,049	.....	.....	1,000	.....	.....	.....	.....	1,000	.....	1,110	1,183	520	.....	.....
Cost delivered ($/M cu. ft.)	0.065	0.205	.....	.....	0.048	.....	.....	.....	.....	0.06	.....	0.1675	0.1017	0.5278	.....	.....
Output Data																
Total gross gen. (millions kwhr)	87.82	314.5	246.4	128.68	237.6	149.1	126.7	338.7	88.8	392.2	304.8	291	367	195.9	477.6	368
Total net gen. (millions kwhr)	83.06	299.8	234.1	123.05	221.7	141.2	119.	324.1	83.7	377.8	287.3	281	355	181.2	447.3	349
Maximum 1-hr peak (Mw)	38	45	49.5	35.62	41.1	33.4	40	48.9	42	55.2	49.83	50.2	51	43.8	70	63.5[7]
Hours operation 1947	3,163	8,731	7,727	8,760	8,760	8,760	8,760	8,760	2,707	8,760	8,760	8,760	8,760	8,760	8,535.9	8,760
Operating Costs (Mills per NET kwhr)																
Fuel	0.70	3.250	3.66	7.46	1.06	4.818	3.640	3.63	1.024	1.027	3.530	2.60	1.3	4.457	3.55	2.554
Wages and superintendence	0.65	0.350	0.33	1.07	0.40	0.594	0.4635	0.45	0.546[4]	0.250	0.635	0.32	0.251	0.531	0.548	0.407
Water, lubrication and supplies	0.14	0.016	0.06	0.07	0.50	0.124	0.1883	0.07	0.082[4]	0.065	0.081	0.36	0.032	0.063	0.133	0.071
Maintenance and repairs, total	0.39	0.270	0.21	0.80	0.35	0.599	0.1370	0.235	0.492[4]	0.204	0.636	0.94	0.243	0.356	0.177	0.153
Buildings and structures	0.01	0.52	0.01	0.155	0.04	0.056	0.0024	0.007	0.086	0.002	0.0688	0.02	0.0009	0.012	0.051	0.0070
Boiler plant	0.04	0.119	0.09	0.168	0.09	0.274	0.2350	0.105	0.177	0.036	0.2960	0.23	0.012	0.202	0.111	0.0500
Fuel handling	.....	.....	.....	0.010	.....	0.109	.....	0.080	.....	0	0.0735	0.01	.....	0.073	0.074	0.0588
Prime movers and aux	0.25	0.068	0.04	0.327	0.18	0.106	0.23	0.036	0.167	0.121	0.0361	0.64	0.01	0.023	0.055	0.0127
Electrical equipment	0.01		0.03	0.104	0.01	0.024	0.2460	0.003	0.022	0.027	0.1145	0.01	0.0008	0.010	0.007	0.0030
Supervision, engrg. and misc	0.08	0.032	0.04	0.032	0.03	0.030	0.0293	0.003	0.040	0.018	0.0468	0.03	0.007	0.036	0.014	0.0218
Total oper. and maint. (excl. fuel)	1.19	0.636	0.39	6.63	1.25	1.317	0.7888	0.755	1.120[4]	0.519	1.353	0.76	0.526	0.950	0.680	0.631
Total production (incl. fuel)	1.89	3.886	4.05	14.09	2.31	6.135	4.4088	4.385	2.144[4]	1.546	4.882	3.37	1.826	5.407	4.231	3.185

(*Continued on page* 86)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Continued)

Station Number	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Investment Data (Dollars per kw)																
(310) Land	0.62	0.33	4.38	7.34	0.05	1.89	.....	1.27	5.21	1.33	0.10	.....	2.38	1.38	1.17	0.528
(311) Structures, improvements	26.27	30.75	54.12	43.21	9.15	25.12	6.10	29.04	45.49	26.60	26.80	.....	16.84	26.30	34.41	18.551
(312) Boiler plant equipment	37.86	30.63	46.09	38.32	20.37	42.28	22.70	31.99	35.72	23.67	44.20	.....	21.52	33.03	48.53	29.702
(314) Turbogenerator units	35.76	31.02	27.38	36.72	25.58	31.36	35.10	31.32	23.29	42.20	36.50	.....	29.75	27.89	32.03	31.771
(315) Accessory elec. equipt	10.68	7.93	9.29	17.14	7.30	9.64	6.87	9.17	11.51	11.80	10.50	.....	5.36	8.56	7.48	5.980
(316) Misc. plant equipt	2.22	0.29	2.76	0.48	1.04	0.37	1.09	1.78	1.96	1.05	1.23	.....	1.50	0.38	1.71	1.349
Total station	113.42	100.95	144.04	143.22	63.49	110.66	71.86	104.57	123.18	106.65	119.33	.....	77.35	97.54	125.33	87.88
Outdoor switching	.....	.....	9.00	.....	5.06	6.32	5.83	10.70	.....	5.67	6.04	.....	10.79	2.44	3.07	17.18
Total sta. and switchyard	.....	100.95	153.04	143.22	68.55	116.98	77.69	115.27	123.18[6]	112.32	125.37	.....	88.14	99.98	128.40	105.06
Building	.....	24.09	.....	.....	.....	.....	5.37	.....	.....	.....	22.40	.....	14.30	.....	23.65	.....
Condensing supply works	.....	5.90	.....	.....	.....	.....	.....	.....	.....	.....	11.04	.....	.....	.....	.....	.....
Fuel handling	.....	2.30	.....	.....	.....	.....	.....	.....	.....	.....	7.53	.....	.....	.....	.....	.....
Ash handling	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.87	.....	.....	.....	.....	.....
Draft system	.....	2.54	.....	.....	.....	.....	.....	.....	.....	.....	1.89	.....	2.26	.....	.....	.....
Feedwater system	.....	5.08	.....	.....	.....	.....	.....	.....	.....	.....	4.19	.....	1.49	.....	.....	.....
Piping system	.....	7.69	.....	.....	.....	.....	5.15	.....	.....	.....	13.46	.....	5.23	.....	.....	.....
Turbogenerators	.....	25.40	.....	.....	.....	.....	20.98	.....	.....	.....	18.15	.....	26.26	.....	.....	.....
Turbine foundations	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.57	.....	.....	.....	.....	.....
Condenser	.....	5.30	.....	.....	.....	.....	2.98	.....	.....	.....	4.25	.....	4.29	.....	.....	.....
Switchgear, station wiring	.....	7.93	.....	.....	.....	.....	.....	.....	.....	.....	8.43	.....	.....	.....	.....	.....
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	2.61[5]	1.765	3.43	6.20	1.81	4.701	3.610	2.13	3.863	2.006	2.927	.....	1.634	4.138	2.151	2.26
Production charges (Table I)	1.89	3.886	4.05	14.09	2.31	6.135	4.433	4.385	2.144	1.546	4.882	3.37	1.827	5.407	4.231	3.20
Total cost	4.50	5.651	7.48	20.29	4.12	10.836	8.043	6.515	6.007	3.552	7.809	.....	3.461	9.545	6.382	5.46
Station Performance 1947																
Billions Btu used	1,010	3,687	2,709	2,673	4,907	2,522.7	1,741	4,144	961	6,492	4,544	4,334	5,366	3,210	5,330	4,439
Fuel cost, cents per million Btu	5.76	26.4	31.6	34.39	4.80	26.97	25.0	28.70	8.9	6.00	22.4	16.75	8.59	26.6	29.6	20.10
Btu per NET kwhr send-out	12,166	.....	11,571	21,727	21,307	17,182	14,500	12,780	11,455	17,184	15,814	15,400	15,115	16,804	11,922	12,728
Btu per GROSS kwhr generated	11,506	.....	10,994	20,776	20,640	16,916	13,700	12,241	10,880	16,530	14,907	14,800	14,621	15,545	11,165	12,081
Aver. boiler efficiency (%)	82	86.97	89.9	76	.....	76	85	86.8	86	79.4	60.6; 85.5	79–82	82.6	81	88.1	87.15
Station thermal eff., NET, (%)	26.95	28.72	29.5	18.5	16.5	19.05	23.6	26.7	29.8	19.9	21.58	20–225	22.58	20.32	28.63	28.25
Employees per 1000 kw per day	0.77	0.89	1.11	1.9	1.41	1.43	0.375	1.65	1.13	0.91	1.58	1.59	0.96	0.7	1.57	0.8
Plant factor, annual (%)	47.85	102.5	91.1	41.4	69.5	42.5	55.9	96.6	73.62	81.1	71	67.5	82.1	44.7	79.28	84.02
Utilization factor, annual (%)	108.57	128.5	146	103.7	105.3	82.5	100	122.2	107.69	122	104	102	102	94.3	104.81	127
Station Space Factors per kw																
Boiler room (cu. ft./kw)	11.30	10.3	1.81	20.08	12.7	23.6	1.11	18.4	1.69	17.36	27.80	.....	15.9	24.6	27.64	17.2
Turbine room (cu. ft./kw)	14.16	12.5	1.92	19.72	15.6	15.6	O.D.	13.7	3.21	11.55	23.30	.....	9.6	15.36	7.88	12.9
Switchhouse (cu. ft./kw)	.....	1.71	0.51	6.05	1.43	4.75	.....	.....	.....	.....	6.23	.....	0.2	1.86	0.36	.....
Office and employee (cu. ft./kw)	.....	1.27	1.27	0.65	0.41	0.41	0.58	0.465	1.31	.....	0.17	.....	.....	0.05	1.34	0.3
Building, ground area (sq. ft./kw)	0.43	0.393	0.58	1.40	0.75	0.735	0.41	0.555	0.26	0.642	0.50	.....	.....	0.67	0.72	0.512
Switchyard (sq. ft./kw)	.....	.....	0.99	1.62	0.23	0.225	0.27	.....	1.44	0.452	0.32	.....	1.3	0.34	0.22	0.460
Fuel storage area (sq. ft./kw)	.....	0.274	2.1	2.80	.....	0.865	0.48	2.08	2.49	.....	1.02	.....	.....	1.28	4.34	10.05
Coal storage (tons/kw)	.....	.....	.....	0.282	.....	0.30	.....	1.25	1.19	.....	0.745	.....	.....	0.36	2.20	1.24

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Includes 75-acre lake. (4) Includes advance training of operators. (5) 4½ months. (6) Provides for additional units. (7) Gross.

(*Continued on page 87*)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Continued)

Station Number*	49	50	51(23E)	52(45)	53(26)	54	55	56	57	58	59	60(29M)	61	62(30T)	63	64
Total generator rating[1]	III	III	III	III	III	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	V
Normal function[2]	(c)	(a)	.....	(a, c, d)	(d)	(a)	(a)	(d)	(a)(b)(c)(f)	(b)	d	(a)	(f)	(a)	(d)[7]	(a)
Initial oper., oldest unit	'20–'29	'10–'19	'30–'34	'35–'39	'30–'34	'10–'19	'30–'34	'00–'09	'10–'19	'10–'19	'40–'45	'30–'34	'10–'19	'20–'29	'20–'29	'20–'30
latest unit	'45–'50	'40–'44	'30–'34	'40–'44	'30–'34	'40–'44	'40–'44	'45–'50	'20–'29	'40–'44	.....	'30–'34	'40–'44	'35–'39	'20–'29	'30–'34
No. of units, condensing	3	4	2	1	1	4	2	5	3	6	1	1	5	3	3	6
Superposed or non-condensing	.....	.....	2	1	1[3]	.....	.....	1	.....	.....	.....	.....	2	.....	.....	.....
Rating range, condensing (Mw)	I–II	I	I, II	III	III	I, II	II	I, II	I, II	I–II	IV	IV	I	II	I, II	I
Sup'p'd or non-cond. (Mw)	.....	.....	I	I	I	.....	.....	I	.....	.....	.....	.....	I	.....	.....	.....
Boilers, number	6	16	3	3	2	8	2	12	16	7	2	3	8	6	7	12
Rating range (Mlbs/hr)	80–300	22–100	250	253–350	250	80–185	300	27–325	30–120	36–275	570	285	40–250	140–300	120–220	89
Steam pressure (s), (psi)	350; 860	200; 825	1,400	900; 820	1,400	260; 650	650	200–1,350	200	190–875	1,050	680	225; 650	425; 825	315; 450	370
Temperature (F)	600–950	525–825	250	825	750	600; 835	825	480–900	500	494–900	915	750	550–750	740; 825	650; 725	575
Cooling water range (F)	58–86	32–85	31–79	35–85	32–85	33–86	40–67	(?)–86	35–105	30–80	50–75	32–78	40–90	32–85	40–95	38–78
Aver. vacuum (in.)	2	28.99	28.75	28.5	28.54	28.3; 28.2	28.54	.....	2	28	29	1.04	1.5	28.84	28	1.46
Plant site area (acres)	25	6.86	27.69	43	133[3]	9.1	45	19.68	31.15	3	14.9	.....	147.3	57.3	13	7.3
In use (acres)	20	2.6	27.69	38	65	9.1	10	19.68	31.15	3	.....	45	147.3	6.8	13	.....
Fuel storage, coal (tons)	.....	25,000	30,000	58,000	30,000	45,000	10,000	.....	50,000	40,000	.....	43,250	75,000	100,000	60,000	40,000
Oil (bbls)	120,000	5,119	580	.....	.....	400	.....	69,000	.....	80,000	110,000	.....	100,000	2,190	.....	30,000
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	58	59	82	94	79	85	43	77	125	118	101	104	109	101	110	132
Operation	37	35	33	34	53	45	26	36	57	46	59	32	58	59	80	52
Maintenance	20	17	39	42	14	27	8	28	49	59	27	43	30	33	24	58
Clerical, stores	1	3	4	6	5	6	2	9	3	2	5	20	6	5	6	5
Fuel handling	.....	4	6	12	7	6	7	.....	12	8	5	5	9	4	.....	9
Guards	.....	.....	0	0	.....	1	0	4	4	3	5	4	.....	.....	.....	8
Station Details																
Stokers, pulverizers	—, —	√, —	—, √	—, √	—, √	√, √	—, √	—, —	√, —	√, √	—, —	—, √	√, √	—, √	—, √	√, —
Air preheater, economizer	√, √	√, √	√, √	√, —	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	—, —
Outdoor boiler, waterwalls	—, √	—, √	—, √	—, √	—, √	—, √	—, √	√, √	—, —	—, √	—, √	—, √	—, √	—, √	—, √	—, —
Automatic combustion system	√	√	—	√	√	√	—	√	.....	√	—	—	√	√	.....	√
Flyash collection; M(ech.), E(lec.)	.....	M	.....	M	—	E	—	.....	M	M, E	—	E	M	.....	.....	—
Stage bleeding, steam reheat	√, —	√, —	√, √	√, —	√, √	√, —	√, —	√, √	.....	√, √	√, —	√, —	√, —	√, —	√, √	—, —
Cooling tower, switchyard	—, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √	√, √	√, —	—, —	—, √	—, √	—, √	—, √	—, —
Duplicate pumps; Feed, Circ	√, √	√, —	√, —	√, —	√, √	√, √	√, —	√, √	√, √	√, √	—, —	√, √	√, √	√, √	√, —	√, —
Generator cooler; Air, Hydrogen	√, √	√, —	√, —	√, √	√, —	√, √	√, √	√, √	√, —	√, √	—, √	—, √	.....	√, —	√, —	√, —
Fuel Consumption																
Coal (short tons)	.....	69,094	135,000	323,522	142,294	225,847	141,108	.....	189,616	88,916	.....	225,562	286,102	128,565	193,966	223,540
Btu per lb	.....	10,451	13,500	12,247	13,288	12,284	12,453	.....	11,050	14,500	.....	10,831	10,092	10,203	13,064	13,608
Ash, moisture (%)	.....	10.46;14.69	9.7; 3.5	10; 7.0	10.0; 5.2	11.9; 5.0	8.66; 6	.....	11.8; 10	8; 4	.....	13.7; 11.7	13; 15	13.81; 13.70	10.06; 4.49	6.76; 4.74
Cost delivered ($/ton)	.....	4.19	7.975	5.45	7.783	6.249	7.758	.....	4.52	9.433	.....	5.11	4.89	4.21	7.748	8.81
Oil (barrels)	629,062	1,149	9,600	.....	.....	8,990	.....	.....	.....	277,061	972,574	.....	5,284	4,021	.....	18,496
Btu per gallon	148,000	137,252	135,000	.....	.....	138,800	.....	.....	.....	153,292	148,800	.....	148,000	137,285	.....	147,864
Cost delivered ($/bbl)	2.05	2.63	5.20	.....	.....	4.75	.....	.....	.....	2.22	1.294	.....	2.58	3.12	.....	2.377
Gas (M cu. ft.)	.....	253,561	.....	1,515,353	.....	.....	.....	3,029,934	.....	.....	.....	2,370,861[6]	.....	1,264,375	.....	.....
Btu per cu. ft	.....	1,044	.....	585.1	.....	.....	.....	1,066	.....	.....	.....	1,000	.....	1,043.8	.....	.....
Cost delivered ($/M cu. ft.)	.....	0.1307	.....	0.0136	.....	.....	.....	0.133	.....	.....	.....	0.24	.....	0.1354	.....	.....
Output Data																
Total gross gen. (millions kwhr)	276.8	93.11	283.7	699	325.4	329.4	288.6	223	152.8	309	542.3	412.5	381.9	274.5	288.0	318.6
Total net gen. (millions kwhr)	264.9	87.98	255.8	676	304.6	308.1	273.2	211	144.4	293	513.8	388.6	345.1	258.2	268.6	315.0
Maximum 1-hr peak (Mw)	65	37.27	56	88	57	63.39	65.1	46.05	49	61.1	65	66	74	71.96	83	76.7
Hours operation 1947	8,760	8,458	8,760	8,760	6,571.5[4]	8,760	8,759	8,760	7,950	8,760	8,660	8,687	8,760	8,760	6,743	8,760
Operating Costs (Mills per NET kwhr)																
Fuel	4.868	3.66	4.365	2.917	3.64	4.601	4.021	1.9	6.207	5.237	2.449	3.11	4.09	2.80	5.59	6.38
Wages and superintendence	0.417	1.15	0.796	0.322	0.33	0.679	0.309	0.7	1.430	1.010	.....	0.40	0.72	0.55	0.53	0.985
Water, lubrication and supplies		0.11	0.167	0.021	0.03	0.115	0.025	0.0	0.096	0.128	.....	0.05	0.08	0.09	0.16	0.142
Maintenance and repairs, total	0.469	1.03	1.076	0.209	0.33	0.635	0.281	0.5	1.190	0.603	.....	0.55	0.39	0.49	0.73	0.917
Buildings and structures	0.0147	0.04	0.165	0.011	0.03	0.0349	.....	0.0	0.1239	0.051	.....	0.05		0.06	0.082	0.14
Boiler plant	0.1959	0.53	0.418	0.139	0.13	0.3430	.....	0.3	0.6634	0.180	.....	0.30	0.25	0.11	0.28	0.21
Fuel handling	0.02	0.05	0.190	0.036	0.11	0.0572	.....	0.0	0.1812	0.077	.....	0.11		0.17	0.21	0.064
Prime movers and aux	0.165	0.25	0.199	0.13	0.02	0.0760	.....	0.2	0.1109	0.181	.....	0.02		0.08	0.085	0.30
Electrical equipment	0.0217	0.04	0.015	0.001	0.02	0.0754	.....	0.0	0.0458	0.023	.....		0.14	0.01	0.04	0.061
Supervision, engrg. and misc	0.0517	0.13	0.089	0.009	0.02	0.0489	.....	0.0	0.0652	0.091	.....	0.07	.....	0.06	0.027	0.142
Total oper. and maint. (excl. fuel)	0.886	2.29	2.039	0.552	0.69	1.429	0.615	1.2	2.716	1.741	.....	1.00	1.19	1.13	1.42	2.04
Total production (incl. fuel)	5.754	5.95	6.404	3.469	4.33	6.030	4.636	3.1	8.923	6.978	.....	4.11	5.28	3.93	7.01	8.42

(Continued on page 88)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Continued)

Station Number	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Investment Data (Dollars per kw)																
(310) Land	0.71	1.03	0.82	.....	1.32	3.00	2.57	0.41	3.04	1.66	.....	9.38	2.40	0.62	0.22	1.65
(311) Structures, improvements	35.25	16.56	24.33	.....	24.86	29.00	19.82	20.08	16.95	17.72	.....	55.09	25.01	21.12	15.46	39.50
(312) Boiler plant equipment	38.00	36.24	58.20	45.41	44.28	35.00	26.11	36.00	28.76	31.40	.....	45.83	52.91	37.35	32.50	38.00
(314) Turbogenerator units	40.65	21.46	24.24	28.03	20.08	27.90	25.48	27.44	22.58	29.30	.....	19.42	31.78	24.62	21.57	24.85
(315) Accessory elec. equipt	8.45	12.61	11.94	6.47	5.69	12.30	6.55	9.55	6.03	14.10	.....	16.26	7.57	8.92	3.63	13.35
(316) Misc. plant equipt	2.70	.60	0.91	.....	1.73	1.58	1.11	1.39	0.24	1.28	.....	0.23	2.15	1.17	0.93	8.41
Total station	115.00	88.50	120.44	.....	97.97	108.78	81.64	94.83	77.60	95.46	.....	146.21	121.82	93.80	74.31	118.30
Outdoor switching	13.75	.....	14.11	2.90	4.44	4.90	7.99	4.35	9.08	.....	.....	6.71	5.05	.....	9.00	.....
Total sta. and switchyard	128.75	.....	134.55	.....	102.41	113.68	89.63	99.18	86.68	95.46	.....	152.98	126.87	.....	83.31	118.30
Building	.....	.....	22.32	.....	23.79	27.70	.....	.....	.....	.....	.....	.....	.....	.....	9.69	26.65
Condensing supply works	.....	.....	.....	.....	2.46	4.87	.....	.....	.....	.....	.....	.....	.....	.....	0.98	4.13
Fuel handling	.....	.....	8.31	.....	8.90	4.79	.....	.....	.....	.....	.....	.....	.....	.....	2.66	4.00
Ash handling	.....	.....	0.67	.....	0.71	1.17	.....	.....	.....	.....	.....	.....	.....	.....	0.88	0.91
Draft system	.....	.....	1.77	3.60	2.93	3.97	.....	.....	.....	.....	.....	.....	.....	.....	1.60	3.01
Feedwater system	.....	.....	6.31	2.32	4.02	3.07	.....	.....	.....	.....	.....	.....	.....	.....	2.11	1.16
Piping system	.....	.....	11.06	10.34	5.29	5.71	.....	.....	.....	.....	.....	.....	.....	.....	7.91	5.57
Turbogenerators	.....	.....	20.03	18.37	12.57	18.97	.....	.....	.....	.....	.....	.....	.....	.....	16.18	15.60
Turbine foundations	.....	.....	0.37	0.51	1.20	0.53	.....	.....	.....	.....	.....	.....	.....	.....	1.41	0.84
Condensers	.....	.....	3.84	3.14	1.86	3.39	.....	.....	.....	.....	.....	.....	.....	.....	2.99	5.27
Switchgear, station wiring	.....	.....	11.94	4.38	5.69	10.62	.....	.....	.....	.....	.....	.....	.....	.....	3.63	13.35
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	3.700	7.55	4.18	.....	2.65	3.025	2.735	4.32	5.58	3.120	.....	3.78	4.18	3.79	3.38	4.23
Production charges (Table I)	5.754	5.95	6.404	3.469	4.33	6.030	4.636	3.10	7.17	6.978	.....	4.11	5.28	3.95	7.0	8.42
Total cost	9.454	13.60	10.594	.....	6.98	9.055	7.371	7.42	12.75	10.098	.....	7.89	9.46	7.74	10.38	12.65
Station Performance 1947																
Billions Btu used	3,908	1,696	3,484.7	8,811	3,782	5,601	3,520	.....	4,191	4,360	6,078.6	5,123	5,807	3,966	5,068	619.6
Fuel cost, cents per million Btu	32.9	18.99	32	22.36	29.29	25.3	31.21	.....	21.39	35.20	20.70	23.60	24	18.23	29.65	32.48
Btu per NET kwhr send-out	14,749	19,274	13,622	13,041	12,416	18,780	12,889	15,312	.....	14,900	11,830	13,183	16,800	15,362	18,864	19,664
Btu per GROSS kwhr generated	.....	18,210	12,272	12,600	12,127	17,002	12,202	.....	.....	14,100	11,209	12,423	15,200	14,451	17,597	19,473
Aver. boiler efficiency (%)	75–85	73.9	78.1	81.95	84	84.6; 61.5	86.29	.....	73.4	85	86	86.7	82	82.0	83.4	76.59
Station thermal eff., NET, (%)	24.18	17.76	25.06	26.17	27.5	18.77	27.99	.....	14.9[5]	23	28.8	25.90	20	22.22	18.1	17.36
Employees per 1000 kw per day	1.16	1.18	1.7	1.70	1.4	1.52	0.72	1.25	2.	1.85	1.56	1.63	0.97	1.45	1.51	1.76
Plant factor, annual (%)	84.5	21.23	65.4	.....	84	63	54.9	40	38.7	55.6	90.23	69.3	54.5	43.54	45.3	48
Utilization factor, annual (%)	130	74.4	105.4	85.70	103.5	113	108.3	75	79	96.1	100	102.9	92.5	103.2	114	102.27
Station Space Factors per kw																
Boiler room (cu. ft./kw)	22	25.37	15.82	.....	20.6	26.7	16.23	.....	.....	23.3	11.33	21.76	45.39	23.6	19.65	44.37
Turbine room (cu. ft./kw)	16	25.06	6.075	.....	14.4	15.7	14.04	.....	.....	11.3	15.09	14.06	14.27	21.3	13.17	13.76
Switchhouse (cu. ft./kw)	3	3.30	1.3	.....	1.5	8.64	2.18	.....	.....	5.8	0.45	0.47	8.17	3.58	0.03	6.01
Office and employee (cu. ft./kw)	1	0.36	0.43	.....	1.0	2.49	0.36	.....	.....	1.2	0.42	0.73	0.21	0.25	0.19	0.40
Building, ground area (sq. ft./kw)	0.67	0.93	0.466	.....	0.4	0.754	0.5	.....	.....	0.80	1.83	1.0	0.84	0.66	0.55	4.24
Switchyard (sq. ft./kw)	0.74	0.102	3.4	.....	1.7	0.439	0.5	.....	.....	0.15	0.06	1.76	0.28	.....	0.88	.....
Fuel storage area (sq. ft./kw)	2.26	1.0	1.9	.....	2.8	1.24	1.5	.....	.....	0.71	0.11	3.13	5.39	3.34	1.4	1.54
Coal storage (tons/kw)	.....	0.5	0.56	1.05	0.5	0.788	0.17	.....	.....	1.65	.....	0.675	0.94	1.43	0.827	0.53

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Compound. (4) 9 months. (5) 11.8% on district steam basis. (6) Therms. (7) Peaking 25%.

(Continued on page 89)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Continued)

Station Number*	65	66(6)	67	68(24)	69	70(40V)	71(41)	72	73	74	75	76	77(34)	78	79(28II)	80
Total generator rating[1]	V	V	V	V	V	V	V	V	VI	VI	VI	VI	VI	VI	VI	VI
Normal function[2]	(a)(c)(d)	(d)	(d)	(a)	(d)	(a)(c)	(a)	(a)(d)	(c)(d)	(a)	(a)	(a)	(a)	(a)(b)(c)(d)	(d)	(d)
Initial oper., oldest unit	'20–'29	'20–'29	'40–'44	'10–'19	'20–'29	'20–'29	'10–'20	'10–'20	'20–'29	'10–'19	'45–'50	'00–'10	'20–'29	'10–'20	'20–'29	'40–'44
latest unit	'40–'44	'45–'50	'40–'44	'40–'44	'40–'44	'35–'39	'35–'40	'40–'45	'20–'29	'40–'44	.....	'35–'39	'40–'44	'45–'50	'40–'44	'40–'44
No. of units, condensing	3	4	2	5	3	3	5	7	2	4	1	7	4	4	2	2
Superposed or non-condensing	.....	.....	.....	1	.....	.....	1	.....	.....	1	.....	I, II	.....	.....	.....	.....
Rating range, condensing (Mw)	II	I, II	III	I–II	II	II	I	I–III	III	I–II	VI	I	II	I–III	IV	IV
Sup'p'd or non-cond. (Mw)	.....	.....	.....	I	.....	.....	III	.....	.....	II	.....	I	.....	.....	.....	.....
Boilers, number	4	4	2	8	9	5	4	12	8	7	2	14	6	5	3	2
Rating (Mlbs/hr)	200–300	130–312	400	60–340	955–200	200–320	175–900	35–200	100–150	42–492	475	40–265	160–350	105–450	400–600	550
Steam pressure (s), (psi)	393; 853	325; 650	950	250; 825	275; 675	400; 875	285; 1,425	200–800	732	260; 1,250	1,375	200–1,200	400; 800	200; 1,200	475; 975	850
Temperature (F)	702; 879	700–900	860	500; 824	560; 825	700; 915	600; 925	550–875	725	560; 925	925	500–910	700; 900	600; 950	725; 860	900
Cooling water range (F)	63–95	34–80	50–85	36.6–77.6	35–94	48–93	38–97	33.7–75.1	32.8–83.4	32–82	38.2–93.1	32–85	32–85	38–87	45–85	32–87
Aver. vacuum (in.)	1.93; 2.22	28	27.69	28.93	26.63; 27.05	28.50	2.19	1.60	1.47	28.20	1.42	1.25	1.5	1.50; 1.35	28.2	1.54
Plant site area (acres)	92.5	76.6	25.28	.....	24	53.96	.....	45.1	62.5	.....	.....	23	103	32.9	668	43.29
In use (acres)	40	56.6	25.28	.....	24	53.96	.....	25.7	62.5	.....	.....	23	30	.....	104	17.83
Fuel storage, coal (tons)	.....	465,000	80,000	50,000	73,000	.....	30,000	60,000	140,400	.....	100,000	60,000	80,000	275,000	.....	300,000
Oil (bbls)	55,000	280	.....	47,500	.....	6,400	.....	270	.....	.....	.....	12,000	180	265,000	715	3,050
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	84	84	66	133	134	87	87	111	189	132	73	170	125	147	87	89
Operation	44	50	36	76	47	38	36	71	83	65	12	77	50	92	51	64
Maintenance	38	16	12	31	68	42	37	25	82	53	18	56	65	35	.....	14
Clerical, stores	2	5	2	8	5	3	5	4	8	8	12	15	4	2	.....	2
Fuel handling	.....	13	13	16	11	.....	6	11	15	4	10	21	8	15	.....	8
Guards	.....	.....	3	3	3	4	3	0	1	2	3	1	3	3	.....	1
Station Details																
Stokers, pulverizers	—, —	—, √	—, √	√, √	.....	—, —	√, √	√, √	√, —	√, —	—, √	√, —	—, √	—, √	—, √	—, √
Air preheater, economizer	√, √	√, √	√, —	√, —	—, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √	√, √
Outdoor boiler, waterwalls	—, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √	.....	—, √	—, √	—, √	—, √	—, √	—, √	—, √
Automatic combustion system	√	√	√	√	√	√	√	√	.....	√	√	.....	√	√	√	√
Flyash collection; M(ech.) E(lec.)	—	.....	.....	M	.....	.....	M	E	M	—	M	.....	M	M	.....	E
Stage bleeding, steam reheat	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, √	√, —	√, —	√, —	√, —	√, —	√, —	√, —
Cooling tower, switchyard	—, √	—, √	—, √	—, —	—	—, √	—, √	—, √	—, √	—, √	—, √	—, —	—, √	—, √	—, √	—, √
Duplicate pumps; Feed, Circ	√, √	√, —	√, √	√, √	√, √	√, √	√, √	√, —	√, —	√, √	√, √	√, √	√, √	√, √	√, √	√, √
Generator cooler; Air, Hydrogen	√, √	√, √	—, √	√, —	√, √	√, —	√, √	√, √	√, —	√, √	—, √	√, —	√, √	—, √	√, √	—, √
Fuel Consumption																
Coal (short tons)	.....	241,322	39,074	391,294	488,903	.....	319,644	275,000	480,035	443,952	393,164	297,302	453,149	95,038	488,675	365,870
Btu per lb	.....	11,030	11,800	11,875	12,056	.....	12,350	13,268	11,326	13,100	11,431	11,550	10,000	13,872	11,350	12,970
Ash, moisture (%)	.....	12.7; 8.7	14; 6	12.5; 6.8	15.7; 5.0	.....	11.61; 5.94	9.61; 4.87	11.9; 11.4	10.6; 3.6	11.63; 8.24	13.2; 8.8	16.4·14.7	8.0; 3.75	15; 9	11.4; 5.08
Cost delivered ($/ton)	.....	.....	4.96	4.68	3.843	.....	4.05	7.54	4.243	3.47	2.70	6.00	3.637	9.14[4]	4.65	7.052
Oil (barrels)	864,730	1,330	169	3,302	.....	11,581	7,089	2,600	.....	.....	2,081	26,100	.....	30,653[4]	1,200	984
Btu per gallon	149,370	139,000	150,000	150,000	.....	147,400	139,838	140,000	.....	.....	137,254	149,360	.....	150,153	150,000	141,917
Cost delivered ($/bbl)	2.01	6.15[3]	2.42	2.46	.....	1.71	5.46	4.56	.....	.....	3.59	2.85	.....	9.14[4]	3.48	2.865
Gas (M cu. ft.)	.....	.....	6,365,623	.....	.....	7,001,841	395	.....	.....	.....	3,085,661	.....	.....	.....	.....	.....
Btu per cu. ft.	.....	.....	1,065	.....	.....	1,061.1	1,100	.....	.....	.....	.....	1,010	.....	.....	.....	.....
Cost delivered ($/M cu. ft.)	.....	.....	0.1225	.....	.....	0.058	0.28	.....	.....	.....	.....	0.155	.....	.....	.....	.....
Output Data																
Total gross gen. (millions kwhr)	397.5	378.4	650	618.45	630.1	563.0	626.1	486.3	826.7	871.0	861.2	624	647	344.90	896	864.5
Total net gen. (millions kwhr)	376.7	357.8	623	596.98	616.2	534.6	595.1	453.8	781.0	832.8	804.2	600	603	323.89	854	820.7
Maximum 1-hr. peak (Mw)	92.5	85	86.9	85.8	96	89.2	95	97.1	104.1	120.1	126	117.5	116	53	130	123
Hours operation 1947	8,760	8,760	8,760	8,760	8,760	8,760	8,746	8,760	8,760	8,760	8,268	8,760	8,760	7,303.75	8,450	8,744
Operating Costs (Mills per NET kwhr)																
Fuel	4.61	4.16	1.56	3.08	3.049	0.80	2.22	4.59	2.5019	1.86	1.26	3.88	2.74	3.57	2.65	3.18
Wages and superintendence	0.37	0.44	0.24	0.24	0.376	0.35	0.37	0.57	0.4512	0.295	0.18	0.66	0.31	0.51	0 32	0.41
Water, lubrication and supplies	0.05	0.06	0.02	0.089	0.117	0.04	0.04	0.10	0.0865	0.046	0.04	0.25	0.04	0.04	0.03	0.04
Maintenance and repairs, total	0.41	0.44	0.14	0.322	0.500	0.31	0.53	0.59	0.2867	0.357	0.23	0.45	0.47	0.45	0.17	0.19
Buildings and structures	0.05	0.06	0.016	0.022	0.071	0.03	0 0135	0.04	0.0271	0.014	0.0003	0.03	0.02	0.04	0.020	0.019
Boiler plant	0.22	0.18	0.041	0.16	0.219	0.07	0.0617	0.28	0.1452	0.165	0.0028	0.21	0.17	0.18	0.079	0.077
Fuel handling	.....	0.08	0.006	0.059	0.031	.....	0.0649	0.14	0.0611	0.073	0 0022	0.04	0.16	0.06	0.043	0.022
Prime movers and aux	0.09	0.07	0.054	0.044	0 126	0.13	0.2606	0.09	0.0140	0.067	0.0011	0.06	0.06	0.11	0.017	0.025
Electrical equipment	.....	0.01	0.009	0.002	0.010	0.02	0.0043	0.02	0.0037	0.017	0.0002	0.04	0.02	0.03	0.002	0.003
Supervision, engrg. and misc	0.06	0.04	0.014	0.035	0.043	0.06	0.0460	0.01	0.0354	0.021	0.0062	0.07	0.04	0.03	0.009	0.044
Total oper. and maint. (excl. fuel)	0.42	0.94	0.40	0.883	0.993	0.69	0.93	1.26	0.8244	0.698	0.45	1.36	0.82	1.00	0.52	0.64
Total production (incl. fuel)	5.03	5.10	1.96	3.962	4.042	1.49	3.15	5.85	3.3263	2 558	1.71	5.24	3.56	4.57	3.17	3.82

(Continued on page 90)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Continued)

Station Number	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Investment Data (Dollars per kw)																
(310) Land	1.77	0.31	0.25	.....	0.11	0.85	.....	1.10	1.74	0.34	.....	2.80	4.66	6.22	0.26	1.318
(311) Structures, improvements	43.50	21.94	12.49	.....	28.70	25.63	.....	28.15	44.72	15.64	.....	22.40	25.99	19.16	22.23	30.754
(312) Boiler plant equipment	47.39	39.87	22.71	.....	36.50	32.11	.....	36.36	47.11	38.40	.....	33.20	26.91	40.71	26.18	35.094
(314) Turbogenerator units	50.48	26.47	22.73	.....	25.00	26.30	.....	22.98	21.64	25.21	.....	33.60	26.85	24.77	18.81	22.656
(315) Accessory elec. equipt	11.51	6.99	6.18	.....	6.92	8.33	.....	7.22	6.27	8.44	.....	12.60	12.75	0.78	6.04	7.840
(316) Misc. plant equipt	1.91	1.07	0.44	.....	2.22	0.41	.....	1.09	2.85	0.78	2.09	0.20	0.80	0.30	0.80	0.804
Total station	156.56	96.65	64.80	.....	99.45	93.63	.....	96.90	124.33	88.81	114.21	105.00	97.96	91.94	74 32	98.465
Outdoor switching	14.13	7.40	6.32	.....	12.40	11.96	.....	11.94	10.61	8.09	13.04	.....	.....	23.34	4.15	4.481
Total sta. and switchyard	170.69	104.05	71.12	.....	111.85	105.59	.....	108.84	134.94	96.90	127.25	.....	.....	115.28	78.47	102.946
Building	.....	14.84	.....	.....	22.00	.....	.....	.....	.....	.....	.....	17.60	.....	.....	.....	15:911
Condensing supply works	.....	3.21	.....	.....	3.00	.....	.....	.....	.....	.....	.....	6.00	.....	.....	.....	4 795
Fuel handling	.....	4.88	.....	.....	5.34	.....	.....	.....	.....	.....	.....	3 10	.....	.....	.....	4.953
Ash handling	.....	0.83	.....	.....	0.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.997
Draft system	.....	3.55	.....	.....	2.96	.....	.....	.....	.....	.....	.....	2.80	.....	.....	.....	5.095[5]
Feedwater system	.....	2.68	.....	.....	3.20	.....	.....	.....	.....	.....	2.41	3.50	.....	.....	.....	3.168
Piping system	.....	6.24	.....	.....	6.00	.....	.....	.....	.....	.....	6.10	7.30	.....	.....	.....	7.371
Turbogenerators	.....	18.71	.....	.....	18.00	.....	.....	.....	.....	.....	13.84	20.40	.....	.....	.....	6.305
Turbine foundations	.....	0.44	.....	.....	0.39	.....	.....	.....	.....	.....	.....	0.50	.....	.....	.....	1.338
Condensers	.....	2.36	.....	.....	2.69	.....	.....	.....	.....	.....	2.90	3.80	.....	.....	.....	3.648
Switchgear, station wiring	.....	3.01	.....	.....	5.50	.....	.....	.....	.....	.....	8.62	11.70	.....	.....	.....	6.904
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	4.33	3.49	1.37	.....	2.175	2.23	.....	3.55	2.59	1.91	2.36	2.70	3.60	2.56	1.66	1.88
Production charges (Table I)	5.03	5.10	1.96	3.96	4.042	1.49	3.15	5.85	3.24	2.56	1.71	5.24	2.80	4.57	3.17	3.82
Total cost	9.36	8.59	3.33	.....	6.217	3.72	.....	9.40	5.83	4.47	4.07	7.94	6.40	7.13	4.83	5.70
Station Performance 1947																
Billions Btu used	5,425	5,364	7,669	9,314	11,788	7,501	8,022	7,320	10,874	11,626	9,012	10,134	9,067	3,645	10,744	9,497
Fuel cost, cents per million Btu	32.0	27.7	12.7	19.74	15.9	5,712	16.45	28.29	17.77	13.2	11.3	22.9	18.2	31.73	21.05	27.2
Btu per NET kwhr send-out	14,400	14,980	12,302	15,602	19,131	14,032	13,427	16,107	13,920	13,960	11,190	16,890	15,100	11,252	12,601	11,571
Btu per GROSS kwhr generated	13,648	14,170	11,801	15,060	18,708	13,324	12,820	15,032	13,149	13,350	10,450	16,240	14,000	10,569	12,006	10,985
Aver. boiler efficiency (%)	85.2	85	81-85	78	68.6; 77.4	82	85.74	79.4	79	86.5	88.52	80.5	81.5	90.21	85.25	86
Station thermal eff., NET, (%)	23.7	22.75	27.76	21.9	17.84	24.37	26	21.1	24.52	24.4	30.52	20.2	22.7	30.3	27.1	29.5
Employees per 1000 kw per day	1.12	1.05	0.9	1.62	1.6	0.59	0.96	1.125	1.89	1.32	0.73	1.65	1.175	.....	0.7	0.741
Plant factor, annual (%)	60.5	51	92.7	83.11	86	75.61	79.1	56.2	90.65	95	98.33	66	89.5	82	85.2	78.6
Utilization factor, annual (%)	123	103.7	108.6	104	120	104.94	105	98.4	104.1	120	126	114	109	110.4[5]	108.3	102.5
Station Space Factors per kw																
Boiler room (cu. ft./kw)	13.33	14.09	14.6	17.17	24.00	20.75	18.30	20.2	43.3	.....	17.93	23.8	.....	.....	17.6	13.933
Turbine room (cu. ft./kw)	9.36	7.02	10.4	7.05	10.89	17.56	7.22	11.6	19.4	.....	12.68	15.5	.....	.....	12.9	11.783
Switchhouse (cu. ft./kw)	0.26	2.064	0.7	0.281	7.15	0.96	0.49	0.17	.....	.....	0.42	7.5	.....	.....	1.1	.....
Office and employee (cu. ft./kw)	0.67	0.23	2.2	0.44	0.67	0.36	0.40	0.172	10.9	.....	0.51	0.5	.....	.....	0.3	1.016
Building, ground area (sq. ft./kw)	3.58	0.536	0.35	0.52	0.50	0.46	0.44	0.525	0.86	.....	0.36	0.7	.....	.....	0.33	0.337
Switchyard (sq. ft./kw)	1.09	1.41	.....	0.116	1.00	0.58	0.93	1.08	0.49	.....	1.8	.....	.....	.....	.....	.....
Fuel storage area (sq. ft./kw)	1.20	90.01	.....	1.2	0.93	.....	0.05	1.02	3.29	.....	1.37	1.2	.....	.....	.....	4.085
Coal storage (tons/kw)	.....	5.8	.....	0.61	0.81	.....	0.33	0.608	4	.....	1.00	.....	.....	.....	2.0	2.5+

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Includes oil. (4) Equivalent to coal at 29,000,000 Btu per ton. (5) On capability basis. (6) Includes dust collector.

(Continued on page 91)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Continued)

Station Number*	81	82	83	84(38I)	85	86(51)	87	88(49)	89	90	91	92	93	94(32F)	95	96
Total generator rating[1]	VI	VI	VII	VII	VII	VII	VII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII	VIII
Normal function[2]	(d)	(a)	(a)	(a)(d)	(a)	(d)	(a)	(a)	(a)	.....	a	a	(a)	(d)	(a)	(d)
Initial oper., oldest unit	'40–'44	'30–'34	'40–'44	'35–'39	'20–'29	'20–'29	'10–'19	'20–'29	'20–'29	'40–'44	'30–'34	'20–'29	'20–'29	'30–'34	'10–'19	'10–'19
latest unit	'45–'50	'45–'50	'40–'44	'40–'44	'45–'50	'35–'39	'40–'44	'45–'50	'45–'50	'45 '50	'40–'44	'40–'41	'40–'44	'45–'50	'45–'50	'40–'44
No. of units, condensing	2	4	2	2	5	3	7	6	6	4	3	4	4	6	8	5
Superposed or non-condensing	0	.....	.....	0	.....	.....	0	2	.....	.....	.....	.....	.....	.....	2	1
Rating range, condensing (Mw)	IV	II	V	II–V	II–III	II–IV	I–II	II	II, III	IV	V	II, III	IV	II, III	I, II	II–V
Sup'p'd or non-cond. (Mw)	0	.....	.....	.....	.....	.....	.....	II	.....	.....	.....	.....	.....	.....	III	III
Boilers, number	4	10	2	2	12	6	10	10	15	4	5	11	12	6	34	14
Rating range (Mlbs/hr)	350	124–400	900	150–640	137–225	250–550	50–385	150–375	100–300	600	560–900	100–550	200–350	375–525	42–1,000	120–600
Steam pressure (s), (psi)	820	400; 850	1,250	1,300	325; 950	400	200–850	230; 1,200	340; 650	850	475; 1,500	650–2,335	600; 650	675	200; 1,625	250; 1,350
Temperature (F)	900	700–900	900	825; 850[3]	650–925	750	550–900	535–900	650; 900	900	900	725–950	725; 910	843; 889	490; 950	600–925
Cooling water range (F)	37–82	35–90	37–75	35–70	33–80	34–75	40–85	39–83	35–88	37–84	34–76	34–88	32–90	43–89	35.7–76.4	38–83
Aver. vacuum (in.)	28.72	14	29	29.44	29	29	1.4	1.25	1.2	0.5–2.0	34, 0.93	1.14	1.89; 1.30	1.33	29	28.6
Plant site area (acres)	205.7	563.25	64	13.2	35.3	15.03	8.5	30.07	42.5	70	42.5	.....	55.5	13.8	3.61	14.42
In use (acres)	201.6	313	46	.....	35.3	15.03	8.5	30.07	6.3	70	.....	.....	51.	13.8	3.61	14.42
Fuel storage, coal (tons)	100,000	200,000	500,000	355,000	85,000	65,000	.....	115,924	200,000	200,000	100,000	300,000	150,000	80,000	9,300	120,000
Oil (bbls)	1,071	7,000	.....	.....	71,429	76,000	29,000	.....	.....	.....	.....	.....	.....	476	100,000	595
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	134	110	180	135	138	198	160	201	242	253	221	239	302	218	245	236
Operation	63	58	74	83	77	56	89	105	100	118	116	100	140[3]	80	.....	179
Maintenance	42	36	61	33	40	97	62	55	91	79	67	91	78	102	.....	31
Clerical, stores	8	4	23	5	6	33	6	4	11	10	8	18	17	4	.....	6
Fuel handling	17	9	18	10	11	8	.....	33	32	35	16	12	30	18	.....	16
Guards	4	3	4	4	4	4	3	4	8	.....	4	18	8	14	.....	4
Station Details																
Stokers, pulverizers	—, ✓	✓, ✓	—, ✓	—, ✓	✓, ✓	—, ✓	—, —	✓, ✓	✓, ✓	—, ✓	—, ✓	✓, ✓	—, ✓	—, ✓	✓, ✓	✓, ✓
Air preheater, economizer	✓, ✓	✓, ✓	✓, ✓	✓, —	✓, ✓	✓, —	✓, ✓	—, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓
Outdoor boiler, waterwalls	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓
Automatic combustion system	✓	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flyash collection; M(ech.), E(lec.)	M	M	M	M	M, E	M, E	—	E	.....	.....	M	M	.....	E	E	M
Stage bleeding, steam reheat	✓, —	✓, —	✓, —	✓, ✓	✓, —	✓, —	✓, —	✓, —	✓, —	✓, —	✓, —	✓, ✓	✓, ✓	✓, —	✓, —	✓, —
Cooling tower, switchyard	—, ✓	✓, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, ✓	—, —	—, ✓	—, ✓	—, —	—, ✓	—, ✓
Duplicate pumps; Feed, Circ.	✓, ✓	✓, —	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	—, —	✓, ✓	✓, —	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓
Generator cooler; Air, Hydrogen	—, ✓	✓, ✓	✓, ✓	✓, ✓	✓, ✓	✓, —	✓, ✓	✓, ✓	✓, —	✓, —	✓, ✓	✓, ✓	✓, ✓	✓, —	✓, ✓	✓, ✓
Fuel Consumption																
Coal (short tons)	278,905	459,271	456,359	480,203	284,089	302,545	.....	539,056	848,837	790,579	738,277	676,032	735,389	720,284	375,284	610,615
Btu per lb	11,880	11,014	12,837	11,662	12,387	13,525	.....	12,988	10,807	11,920	12,755	11,090	12,864	13,694	13,457	13,175
Ash, moisture (%)	8.2; 6	10.2; 12.8	10.1; 6.5	13.2; 7.4	10.49; 7.20	8.3; 4.85	.....	9.22; 4.79	3.75; 12.50	15.31; 4.68	10.35; 5.26	11.31; 12.38	10.06; 5.28	8.9; 3.61	9.7; 4.0	10.33; 4.11
Cost delivered ($/ton)	3.51	4.298	6.413	6.64	9.8153	8.29	.....	6.87	3.49	5.12	6.42	4.62	5.619	7.71	8.029	7.338
Oil (barrels)	432.8	2,750	.....	.....	122,849	220,511	.....	.....	.....	.....	.....	4,602	.....	1,411	192,764	611,395
Btu per gallon	150,000	138,029	.....	.....	152,000	149,100	.....	.....	.....	.....	.....	140,430	.....	135,000	149,366	151,429
Cost delivered ($/bbl)	3.18	3.00	.....	.....	2.3628	2.15	.....	.....	.....	.....	.....	3.05	.....	3.07	2.3898	2.21
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	13,881,321	12,219	.....	.....	877,890	.....	.....	1,422	.....	.....
Btu per cu. ft	.....	.....	.....	.....	.....	.....	1,101	1,026	.....	.....	544	.....	.....	692	.....	.....
Cost delivered ($/M cu. ft.)	.....	.....	.....	.....	.....	.....	0.095	0.3927	.....	.....	0.107	.....	.....	0.71	.....	.....
Output Data																
Total gross gen. (millions kwhr)	548	757	1,132	1,116.5	602.9	728.2	1,032	1,081	1,337	1,738.5	1,647.2	1,311.5	1,506.7	1,730	715	1,518
Total net gen. (millions kwhr)	527	714	1,060	1,056.5	573.2	680.5	978	1,030	1,261	1,655.9	1,554.8	1,231	1,406.7	1,641	697	1,449
Maximum 1-hr. peak (Mw)	124	158	195	160	175.1	158.8	180	212	246.1	261	275	259	264	294	284	289
Hours operation 1947	8,656	8,760	8,760	8,760	5,880	8,760	8,760	8,760	8,760	8,760	8,760	8,744	8,760	.....	8,760	8,760
Operating Costs (Mills per NET kwhr)																
Fuel	1.94	2.77	2.769	3.016	5.316	4.47	1.346	3.6	2.349	2.428	3.10	2.59	2.920	3.387	5.29	4.08
Wages and superintendence	0.40	0.48	0.289	0.371	0.327	0.48	0.341	0.413	0.362	0.252	0.349	0.34	0.521	0.298	1.25	0.33
Water, lubrication and supplies	0.09	0.10	0.045	0.049	0.030	0.06	0.050	0.0697	0.042	0.016	0.046	0.06	0.062	0.018	0.14	0.03
Maintenance and repairs, total	0.30	0.48	0.314	0.192	0.373	0.660	0.449	0.482	0.412	0.209	0.329	0.38	0.410	0.269	1.54	0.66
Buildings and structures	0.075	0.05	0.034	0.011	0.004	0.082	0.092	0.0364	0.054	0.010	0.015	0.019	0.042	0.018	0.29	0.08
Boiler plant	0.116	0.24	0.146	0.082	0.260	0.229	0.086	0.1662	0.174	0.122	0.140	0.200	0.142	0.066	0.58	0.27
Fuel handling	0.056	0.09	0.047	0.055	.....	0.140	.....	0.1389	0.073	0.050	0.090	0.044	0.119	0.090	0.19	0.17
Prime movers and aux	0.026	0.06	0.041	0.018	0.082	0.099	0.147	0.0869	0.077	0.007	0.060	0.052	0.049	0.052	0.42	0.08
Electrical equipment	0.015	0.00	0.002	0.015	.....	0.027	0.028	0.0077	0.014	0.004	0.004	0.001	0.008	0.020		0.04
Supervision, engrg. and misc.	0.017	0.04	0.043	0.011	0.004	0.055	0.096	0.0459	0.020	0.016	0.020	0.068	0.050	0.023	0.06	0.02
Total oper. and maint. (excl. fuel)	0.79	1.06	0.648	0.612	0.730	1.20	0.840	0.964	0.816	0.477	0.724	0.78	0.993	0.585	2.93	1.02
Total production (incl. fuel)	2.73	3.83	3.417	3.628	6.046	5.66	2.186	4.564	3.165	2.905	3.824	3.37	3.913	3.972	8.22	5.10

(*Continued on page* 92)

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Continued)

Station Number	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Investment Data (Dollars per kw)																
(310) Land	6.596	0.84	1.38	1.52	0.65	0.41	1.90	0.25	0.47	0.10	1.24	.....	0.14	1.49	2.09	0.26
(311) Structures, improvements	40.879	25.27	24.20	27.11	32.65	24.08	25.56	16.30	19.34	14.51	16.66	.....	29.00	12.92	16.82	29.90
(312) Boiler plant equipment	33.576	42.20	31.11	30.92	43.47	37.73	25.02	24.84	33.30	30.90	28.40	.....	31.70[4]	30.19	41.69	33.10
(314) Turbogenerator units	21.028	30.72	22.40	23.28	28.83	19.94	22.73	25.09	25.29	25.88	19.75	.....	27.90	25.05	20.57	24.80
(315) Accessory elec. equipt	6.652	8.18	4.35	5.06	9.86	10.71	14.66	7.46	7.89	6.00	3.41	.....	9.93	14.06	19.25	11.40
(316) Misc. plant equipt	0.952	0.68	1.66	1.23	1.63	0.34	1.07	0.65	0.50	1.22	1.84	1.14	0.99	0.39	0.66	1.18
Total station	118.00	107.89	85.10	89.12	116.64	93.21	90.94	74.60	86.79	78.61	71.30	87.82	99.66	84.10	101.08	100.64
Outdoor switching	3.553	9.66	5.82	4.07	7.26	5.31	.....	5.34	8.43	3.97	8.38	6.06	5.44	.....	1.93	3.75
Total sta. and switchyard	121.615	117.55	90.92	93.19	123.90	98.58	90.94	79.94	95.22	82.58	79.68	93.88	105.10	84.10	103.01	104.39
Building	4.97	25.27	13.84	.....	27.68	22.51	.....	15.53	.....	11.68	.....	.....	24.30	11.09	15.52	27.60
Condensing supply works	0.50	3.35	4.81	.....	2.10	1.21	.....	0.77	.....	3.44	.....	.....	3.68	3.51	1.13	2.00
Fuel handling	8.38	5.09	4.95	.....	5.04	5.68	.....	3.41	.....	4.52	.....	.....	7.38	4.60	5.18	2.26
Ash handling	2.02	1.86	0.74	.....	1.40	1.53	.....		.....	0.90	.....	.....	0.38	1.25	3.53	0.69
Draft system	4.11	4.47	3.04	.....	6.35	3.46	.....	.....	.....	3.09	.....	.....	1.99	5.48	4.97	5.10
Feedwater system	3.591	4.50	4.98	.....	4.37	2.76	.....	.....	.....	2.16	.....	.....	2.22	2.41	6.22	3.10
Piping system	8.378	9.75	3.72	.....	8.80	4.76	.....	2.37	.....	5.52	.....	.....	7.82	6.18	4.97	9.06
Turbogenerators	14.631	21.68	17.43	.....	20.60	14.04	.....	25.09	.....	19.08	.....	.....	19.90	16.56	17.04	16.20
Turbine foundations	0.498	0.70	0.55	.....	.....	.....	.....	.....	.....	0.57	.....	.....	0.98	0.63	.....	1.75
Condensers	2.61	3.14	2.74	.....	5.45	3.27	.....	.....	.....	2.06	.....	.....	4.05	2.28	3.17	4.50
Switchgear, station wiring	6.653	7.18	.....	.....	8.14	15.68	.....	.....	.....	3.83	.....	.....	9.94	8.80	19.25	9.35
Cost of Energy (Mills per NET kwhr)																
Fixed charges at 15 percent	3.63	3.66	3.417	2.117	3.632	3.69	2.552	2.282	2.549	1.778	3.82	2.74	2.87	2.026	6.00	2.83
Production charges (Table I)	2.73	3.83	2.059	3.628	6.046	5.66	2.186	4.564	3.165	2.922	1.84	3.37	3.913	3.972	8.22	5.10
Total cost	6.36	7.49	5.476	5.745	9.678	9.35	4.738	6.846	5.714	4.700	5.66	6.11	6.783	6.048	14.22	7.93
Station Performance 1947																
Billions Btu used	6,629	10,124	11,706	112,001	7,809	9,564.7	14,830	14,025	18,347	18,847	19,332	15,028	18,920	19,730	11,310	19,967
Fuel cost, cents per million Btu	14.78	19.55	25.07	28.45	39.02	31.1	8.8	26.44	16.14	21.46	24.82	21.2	21.7	28.2	30.72	29.2
Btu per NET kwhr send-out	12,578	15,368	11,048	10,600	13,625	14,189	15,226	13,614	14,549	11,314	12,122	12,132	13,456	12,026	16,217	13,782
Btu per GROSS kwhr generated	12,094	14,192	10,343	10,031	12,952	13,260	14,450	12,978	13,724	10,841	11,435	11,470	12,555	11,408	15,823	13,153
Aver. boiler efficiency (%)	81.74	77.2	.....	86.36	83.1	85.5	81	82.71	81.65	88.5	.....	85.2	85.74	88	80.9	80.1
Station thermal eff., NET, (%)	27.14	24.0	30.89	32.22	26.7	24.05	22.4	25.06	23.5	30.17	29.80	28.13	25.4	28.38	21.0	24.8
Employees per 1000 kw per day	1.03	0.73	1.125	0.84	0.83	1.17	0.86	0.96	1.076	0.75	0.92	0.99	1.18	0.81	0.94	0.87
Plant factor, annual (%)	92.6	58.2	76.5	83.4	58.0	49	61.02	58.76	63.98	82.7	78.3	62	67.1	73.1	38.8	63.6
Utilization factor, annual (%)	93.7	106.3	122	100	104.2	93.5	100.3	100.95	109.38	108.8	115	107	103	108.8	109.2	106.2
Station Space Factors per kw																
Boiler room (cu. ft./kw)	17.56	26.0	12.765	15.6	17.59	15.1	19.17	14.10	17.23	12.789	16.6	31.10	19.65	12.96	23.64	17.9
Turbine room (cu. ft./kw)	6.913	10.3	10.332	8.8	10.77	10.3	11.30	9.32	10.41	8.669	9.0	21.90	9.68	10.18	7.14	14.0
Switchhouse (cu. ft./kw)	0.090	1.7	.....	4.1	0.15	1.2	4.85	1.95	1.54	.....	2.5	0.58	3.68	4.37	3.01	4.5
Office and employee (cu. ft./kw)	0.623	1.7	3.803	0.8	1.22	1.2	1.04	0.32	0.55	1.415	.....	0.50	2.17	0.20	1.46	0.06
Building, ground area (sq. ft./kw)	0.415	0.44	0.357	.....	0.35	0.27	0.44	0.282	0.42	0.209	0.35	0.56	0.46	0.36	0.21	0.39
Switchyard (sq. ft./kw)	0.165	0.79	0.384	.....	0.61	0.13	.....	0.215	0.44	0.124	.....	1.66	0.54	.....	0.14	0.134
Fuel storage area (sq. ft./kw)	1.047	2.28	2.250	1.93	1.19	0.88	1.03	0.79	1.75	1.82	.....	11.00	1.93	0.52	0.023	0.66
Coal storage (tons/kw)	0.769	1.35	3.125	2.22	0.60	0.383	0.13	0.552	0.88	0.833	0.42	0.70	0.60	0.30	0.034	0.44

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups, kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station; (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Same for reheat. (4) Boilers $13.38.

(*Continued on page 93*)

TABLE I—Steam Station Equipment Data And Production Costs (1947)—(Concluded)

Station Number*	97(55Q)	98(52)	99	100(54)	101	102	103[6]	104	105(35)	106	107	108	109	110	111	112	113
Total generator rating[1]	VIII	VIII	VIII	VIII	VIII	VIII	V	I	VI	VI	VI	IV	I	III	III	VII	IV
Normal function[2]	(d)	(d)	(a)	.....	(abcde)	(a)	(a)	(abcd)	(a)(c)(d)	(abcd)	(abcd)	(a)(d)	(ade)	(a)(d)	(abcd)	(acd)	(a)
Initial oper., oldest unit	'20–'29	'20–'29	'10–'20	'10–'19	'10–'19	'20–'29	'10–'19	'10–'19	'35–'39	'20–'29	'40–'44	'35–'39	'40–'44	'40–'44	'20–'29	'20–'29	'20–'29
latest unit	'35–'39	'45–'50	'40–'44	'45–'50	'40–'44	'45–'50	'40–'44	'20–'29	'40–'44	'30–'34	'40–'44	'45–'50	'40–'44	'45–'50	'35–'39	'40–'44	'45–'50
No. of units, condensing	3	6	5	6	11	8	7	3	3	5	6	2	1	2	2	5	5
Superposed or non-condensing	.....	1	1	1	.....	1	1	0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rating range, condensing (Mw)	IV–VII	II–V	I–VI	II–VI	I–VI	II–VII	I, II	I	II, III	II	II, III	II	I	II	II	II, III	I, II
Sup'p'd or non-cond. (Mw)	.....	III	I	III	.....	IV	I	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Boilers, number	14	12	5	15	53	22	17	5	3	16	3	2	1	4	3	9	6
Rating range (Mlbs/hr)	170–600	150–800	525–550	135–1,000	375–400	155–975	90–300	40–100	400–550	120–140	400–550	400–450	150	125	180–225	250–400	125–225
Steam pressure (s), (psi)	400–425	323–1,254	650; 1,250	225; 1,250	200; 450	280; 950	300; 665	220	800	350–385	800–900	800–900	400	650	400; 850	370; 850	400; 900
Temperature (F)	703–850	649–928	850; 950	500–1,000	500; 750	575–950	550; 835	550	850	690–725	850–900	850–900	750	800	692; 900	700; 850	690; 900
Cooling water range (F)	35–83	32–80	36–78	40–81	55–75	37.6–74.9	34–85	32–80	34–85	34–85	34–85	38–86	33–70	26–70	34–73	34–89	34–86
Aver. vacuum (in.)	28.70	1.53–2.10	.....	.....	28.5	29	28	1	1–1½	2	1–1.8	0.8–2.4	1	1	0.8–1.6	0.8–2.36	28.9
Plant site area (acres)	56.04	92	115	44	43.8	7.76	10.1	.....	1,000[5]	.....	800	.....	3.32	42.25	.....	.....	25.82
In use (acres)	31.02	92	115	44	32.3	7.76	10.0	.....	1,000	20	15	.....	2.72	10.0	.....	.....	20
Fuel storage, coal (tons)	270,000	150,000	200,000	160,000	.....	40,350	50,000	0	200,000	300,000	325,000	75,000	.....	50,000	30,000	300,000	60,000
Oil (bbls)	357	.....	120,000	20,000	170,000	24,000	400	.....	.....	.....	.....	.....	80,000	100,000	.....	.....	200
Gas (M cu. ft.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Employees, total, (24 hrs.)	208	366	403	404	346	570	196	34	85	159	77	65	24	45	52	225	95
Operation	155	218	194	181	190	.....	.....	24	48	81	54	.....	22	37	.....	.....	43
Maintenance	25	105	106	138	131	.....	.....	3	12	48	10	.....	2	2	.....	.....	31
Clerical, stores	8	19	18	17	15	.....	.....	2	1	3	1	.....	.....	.....	.....	.....	8
Fuel handling	16	16	43[3]	32[4]	6	.....	.....	4	20	23	8	.....	.....	6	.....	.....	9
Guards	4	8	6	4	4	.....	.....	1	4	4	4	.....	.....	.....	.....	.....	4
Station Details																	
Stokers, pulverizers	√, √	√, √	—, √	—, √	—, —	√, √	√, √	√, —	—, √	√, —	—, √	—, √	—, √	—, √	√, √	—, √	√, √
Air preheater, economizer	√, √	√, √	√, √	√, √	√, √	√, √	√, √	—, √	√, √	√, √	√, √	√, √	√, —	√, √	√, √	√, √	√, √
Outdoor boiler, waterwalls	—, √	—, √	—, √	—, √	—, √	—, √	√, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √	—, √
Automatic combustion system	√	√	√	√	√	√	√	—	√	√	√	√	√	√	√	√	√
Flyash collection; M(ech.), E(lec.)	E	E	E	E	.....	E	M, E	.. ..	M	.....	M	M	M	M	M	—	M
Stage bleeding, steam reheat	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —	√, —
Cooling tower, switchyard	—, √	—, √	—, √	—, √	—, √	—, √	—, —	—, √	—, √	—, √	—, √	—, —	—, √	—, √	—, √	—, √	—, √
Duplicate pumps; Feed, Circ	√, √	—, √	.....	.....	√, √	√, √	√, √	√, —	—, —	—, —	—, √	—, √	√, √	—, √	—, √	—, √	√, √
Generator cooler; Air, Hydrogen	√, —	√, √	√, √	√, √	√, √	√, √	√, —	—, —	—, √	√, —	—, √	—, √	√, —	√, —	√, —	√, √	√, √
Fuel Consumption																	
Coal (short tons)	838,212	1,202,977	923,675	395,871	.....	1,778,581	258,540	87,985	417,000	476,000	453,000	155,000	.....	42,423	126,000	801,000	233,671
Btu per lb	13,386	12,570	12,735	13,183	.....	13,351	12,600	13,013	12,100	12,335	12,400	12,143	.....	14,942	12,607	12,135	10,642
Ash, moisture (%)	9.26; 4.07	13.6; 3.3	—; 5.33	.....	.....	8.9; 4.7	.....	8;5	.....	.....	.....	.....	.....	3½; 6.7	.....	.....	12.5; 13.0
Cost delivered ($/ton)	7.27	3.06	6.626	7.777	.....	8.019	6.37	8.04	7.55	6.87	6.68	4.60	.....	9.87	6.36	3.66	3.04
Oil (barrels)	.....	.....	112,916	935,203	4,913,110	43,363	1,964	.....	.....	.....	.....	.....	117,094	121,563	.....	.....	.....
Btu per gallon	.....	.....	150,200	149,300	148,810	148,859	125,600	.....	.....	.....	.....	.....	154,000	154,000	.....	.....	.....
Cost delivered ($/bbl)	.....	.....	2.029	2.26	1.623	2.1252	3.17	.....	.....	.....	.....	.....	2.16	2.02	.....	.....	.....
Gas (M cu. ft.)	.....	.....	.....	.....	8,567,994	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Btu per cu. ft.	.....	.....	.....	.....	1,117	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cost delivered ($/M cu. ft.)	.....	.....	.....	.....	0.1845	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Output Data																	
Total gross gen. (millions kwhr)	1,736	2,223.8	2,036	1,118	2,664	3,368	374.16	98.65	.....	.....	.....	.....	53.0	139	.....	.....	369.8
Total net gen. (millions kwhr)	1,647	2,075.2	1,955	1,070	2,575	3,244	336.95	94.90	877	698	980	322.6	50.8	130.9	222	1,330	346.9
Maximum 1-hr. peak (Mw)	267	318.9	298	327	437	593	61.908	17.5	150	167	152	90	16	45	42.7	186.4	77.6
Hours operation 1947	8,760	.....	8,760	8,760	.....	8,760	8,760	8,760	8,760	8,760	8,760	8,760	3,778	5,967	8,760	8,760	8,760
Operating Costs (Mills per NET kwhr)																	
Fuel	3.78	1.775	3.265	4.888	3.709	4.56	4.83	7.54	3.58	4.63	3.086	2.12	4.77	5.08	3.62	2.200	2.1
Wages and superintendence	0.27	0.580	0.397	0.656	0.322	0.58	1.53	0.608	0.188	0.415	0.170	0.36	1.46	0.92	0.62	0.354	0.5
Water, lubrication and supplies	0.03	0.051	0.064	0.102	0.043	0.09	0.067	0.040	0.027	0.062	0.025	0.06	0.54	0.06	0.07	0.041	0.1
Maintenance and repairs, total	0.45	0.378	0.413	0.959	0.566	1.27	0.82	0.188	0.175	0.643	0.158	0.35	0.20	0.31	0.37	0.315	0.4
Buildings and structures	0.08	0.021	0.042	0.164	0.065	0.06	0.16	0.007	0.007	0.038	0.003	0.07	0.06	0.09	0.05	0.070	0.03
Boiler plant	0.14	0.125	0.095	0.194	0.231	0.85	0.24	0.145	0.081	0.197	0.072	0.20	0.07	0.10	0.20	0.100	0.07
Fuel handling	0.13	0.060	0.077	0.104	0.005	0.21	0.20	0.044	0.030	0.264	0.023	0.04	.....	0.04	0.08	0.105	0.10
Prime movers and aux	0.04	0.110	0.059	0.178	0.149	0.10	0.03	0.004	0.030	0.089	0.035	0.02	0.01	0.06	0.01	0.010	0.10
Electrical equipment	0.04	0.020	0.013	0.066	0.010		0.05	.....	0.003	0.011	0.004	0.01	0.06	0.02	0.01	0.010	0.03
Supervision, engrg. and misc.	0.02	0.042	0.127	0.233	0.069	0.05	0.15	.....	0.024	0.044	0.021	0.01	.....	.....	0.02	0.020	0.07
Total oper. and maint. (excl. fuel)	0.75	0.821	0.874	1.717	0.932	1.94	2.42	0.836	0.39	1.12	0.353	0.77	2.20	1.29	1.06	0.710	1.0
Total production (incl. fuel)	4.53	2.596	4.139	6.605	4.641	6.50	7.25	8.37	3.97	5.75	3.439	2.89	6.97	6.37	4.68	2.910	3.1

TABLE II—Steam Station Unit Investment Cost, Total Power Cost And Performance (1947)—(Concluded)

Station Number	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
Investment Data (Dollars per kw)																	
(310) Land	1.94	1.40	0.83	2.48	1.01	1.20	1.39	1.38	.....	.....	.....	.....	4.33	1.38	.....	.....	0.70
(311) Structures, improvements	35.70	26.60	14.73	18.08	17.08	25.93	36.40	9.41	.....	.....	.....	.....	30.03	51.61	.....	.....	21.54
(312) Boiler plant equipment	27.50	40.70	30.45	32.60	28.88	40.21	39.30	47.66	.....	.....	.....	.....	25.25	51.60	.....	.....	37.40
(314) Turbogenerator units	22.50	22.80	19.38	19.30	26.57	20.65	24.10	29.35	.....	.....	.....	.....	39.31	32.96	.....	.....	31.37
(315) Accessory elec. equipt	13.75	8.90	9.99	12.60	5.28	25.58	19.40	8.29	.....	.....	.....	.....	10.73	9.88	.....	.....	11.72
(316) Misc. plant equipt	1.23	1.60	0.69	0.50	0.42	0.84	4.75	1.35	.....	.....	.....	.....	1.19	0.79	.....	.....	0.91
Total station	102.62	102.00	76.07	85.50	79.24	114.41	125.34	87.44	69.30	88.49	73.30	71.50	110.84	148.22	96.0	109.00	103.64
Outdoor switching	2.87	6.00	8.67	7.85	8.94	1.12	.....	12.17	8.70	14.10	16.70	8.00	26.03	15.48	7.5	7.0	.....
Total sta. and switchyard	105.49	108.00	84.74	93.35	88.18	115.53	.....	99.61	78.00	102.59	90.00	79.50	136.87	163.70	103.5	116.00	103.64
Building	32.00	21.90	.....	.....	.....	22.36	.....	.....	.....	.....	.....	.....	22.93	26.20	.....	.....	.....
Condensing supply works	3.26	2.60	.....	.....	.....	1.20	.....	.....	.....	.....	.....	.....	4.48	4.38	.....	.....	.....
Fuel handling	2.54	9.80	.....	.....	.....	6.94	.....	.....	.....	.....	.....	.....	20.27	23.53	.....	.....	.....
Ash handling	0.69	2.30	.....	.....	.....	2.44	.....	.....	.....	.....	.....	.....	1.00	2.33	.....	.....	.....
Draft system	4.53	3.00	.....	.....	.....	3.50	.....	.....	.....	.....	.....	.....	0.99	3.97	.....	.....	.....
Feedwater system	1.26	3.60	.....	.....	.....	3.44	.....	.....	.....	.....	.....	.....	6.02	7.39	.....	.....	.....
Piping system	6.65	10.00	.....	.....	.....	6.44	.....	.....	.....	.....	.....	.....	4.67	5.40	.....	.....	.....
Turbogenerators	14.25	17.50	.....	.....	.....	15.16	.....	.....	.....	.....	.....	.....	23.72	21.48	.....	.....	.....
Turbine foundations	1.37	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.72	2.83	.....	.....	.....
Condensers	2.93	4.50	.....	.....	.....	4.24	.....	.....	.....	.....	.....	.....	5.35	5.23	.....	.....	.....
Switchgear, station wiring	11.62	7.50	.....	.....	.....	24.23	.....	.....	.....	.....	.....	.....	10.73	9.89	.....	.....	.....
Cost of Energy (Mills per NET kwhr)																	
Fixed charges at 15 percent	2.67	2.265	1.981	4.200	2.273	3.37	5.79	2.97	1.77	3.08	1.82	.....	5.60	5.10	2.80	2.36	2.5
Production charges (Table I)	4.53	2.596	4.139	6.605	4.641	6.50	7.25	8.37	3.97	5.75	3.44	2.89	6.97	6.37	4.68	2.91	3.1
Total cost	7.20	4.861	6.120	10.805	6.914	9.87	13.04	11.34	5.74	8.83	5.26	.....	12.57	11.47	7.48	5.27	5.6
Station Performance 1947																	
Billions Btu used	22,441	30,243	24,367	16,640	40,278	14,764	6,550	2,287.5	10,100	11,500	11,250	3,764	757.4	2,054	3,180	19,450	4,973
Fuel cost, cents per million Btu	27.2	12.2	26.195	31.955	23.7	30.05	25	31.3	31.2	27.9	26.9	18.11	32	32.4	25.22	15.08	14.28
Btu per NET kwhr send-out	13,623	14,569	12,466	15,552	15,643	14,724	19,280	24,104	11,489	16,473	11,443	11,706	14,901	15,693	14,361	14,618	14,337
Btu per GROSS kwhr generated	12,925	13,600	11,670	14,900	15,117	14,182	17,300	23,191	.....	.....	.....	.....	14,279	14,773	.....	.....	13,448
Aver. boiler efficiency (%)	82.4	84.2	82; 88.4	72.2; 82.1	.....	84.3	85	65.8	88	82.4	87.5	89.91	84	86	85.1; 89.4	81.1; 88.6	87.8
Station thermal eff., NET, (%)	25.1	23.43	27.4	22	.....	23.1	19.3	14.16	29.7	20.7	29.8	29.0	23	24.22	23.8	23.4	23.8
Employees per 1000 kw per day	0.73	1.26	1.32	1.26	1.18	0.905	2.24	2.26	0.71	1.14	0.642	0.74	1.92	1.12	1.3	1.25	1.31
Plant factor, annual (%)	69.5	82.8	73.1	38.1	69.85	58.8	44.0	75	76	57.0	85	.....	48.5	63.3	63.3	84.3	54.6
Utilization factor, annual (%)	94	110	97.8	102	98.8	95.1	70.6	11.6	125	118	126.7	.....	128	112.5	106.8	106.5	107
Station Space Factors per kw																	
Boiler room (cu. ft./kw)	23.7	28.7	8.75	12.18	22.03	13.70	22.4	13.0	.....	.....	.....	.....	21.0	29.4	.....	.....	19.35
Turbine room (cu. ft./kw)	20.2	12.8	8.8	9.35	11.62	8.63	14.5	4.5	.....	.....	.....	.....	10.4	19.4	.....	.....	15.11
Switchhouse (cu. ft./kw)	8.6	0.2	0.748	4.66	4.61	7.78	.....	10.6	.....	.....	.....	.....	.....	.....	.....	.....	.....
Office and employee (cu. ft./kw)	0.18	2.2	0.99	0.55	0.550	0.71	0.248	12.6	.....	.....	.....	.....	.....	0.135	.....	.....	0.46
Building, ground area (sq. ft./kw)	0.58	.....	0.33	0.384	4.32	0.24	4.89	0.84	.....	.....	.....	.....	0.76	0.82	.....	.....	0.44
Switchyard (sq. ft./kw)	0.4	.....	0.525	0.538	0.26	0.057	.....	0.64	.....	.....	.....	.....	3.94	0.78	.....	.....	0.22
Fuel storage area (sq. ft./kw)	0.77	.....	1.0	1.0	0.41	0.119	0.56	.....	.....	.....	.....	.....	8.33	5.85	.....	.....	2.50
Coal storage (tons/kw)	0.95	0.5	0.656	0.50	.....	0.064	0.571	.....	.....	.....	.....	.....	.....	1.25	.....	.....	0.83

* Figures and letters in parentheses refer to the Third and Fourth Steam Station Cost Surveys (October 9, 1937 and December 2, 1939 respectively).
(1) Rating groups; kw.: I, to 19,000; II, 20,000–39,000; III, 40,000–59,000; IV, 60,000–74,000; V, 75,000–99,000; VI, 100,000–149,000; VII, 150,000–199,000; VIII, 200,000 plus.
(2) Normal function; (a) Normal system station: (b) Normal distribution station; (c) Normal transmission station; (d) Normal base load; (e) Standby; (f) Power and district steam.
(3) Includes yard, others total 36. (4) Includes yard, others total 32. (5) Includes yard.
(6) Stations 103–113 inclusive are included in the tabulation of characteristics but not in the illustrations.

Station Characteristics And Auxiliaries

AMONG the 112 plants analyzed statistically pulverizer operation exceeds stoker operation better than three to two. Many plants which have retained the low pressure equipment, of course, have both equipments.

Air preheaters are reported for 91 and as commonly for small plants as for large.

est in this measure of thermodynamic economy.

Reheat Gains

Reheat of the steam at the boiler after it has given up some of its energy in the turbine is a promising and profitable way of using fuel heat efficiently and advantageously. Most fortunate about this technical trick count. The other 1.5 percent is attributable to the higher temperature and this may entail a $50,000 greater outlay for the turbine and $80,000 for the boiler. But the efficiency should advance to 10,715 Btu, carrying the fuel expenditure down to $1,460,000. The annual saving of $40,000 returns about 30 percent on the incremental investment. That is

Fuel And Equipment Characteristics Of 112 Stations

Rating Group	I		II		III		IV		V		VI		VII		VIII		Totals
No. of Stations	17		21		18		12		10		13		6		15		112
	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	Partly	Gen'ly	
Stoker	...	5	...	...	4	1	4	1	4	2	1	4	1	...	8	...	41
Pulverizer	...	3	2	6	4	7	4	6	4	2	1	9	1	4	8	6	67
Air Preheater	...	8	...	17	...	16	...	11	...	7	...	13	...	5	...	14	91
Economizer	...	3	...	8	...	11	...	11	...	7	...	12	...	4	...	15	71
Outdoor Boiler	1	3	...	5	...	2	...	1	...	...	...	...	...	...	...	...	12
Water Walls	...	12	...	19	...	17	...	12	...	9	...	12	...	6	...	15	102
Auto. Comb. System	...	5	...	14	...	15	...	5	...	9	...	11	...	5	...	14	78
Flyash Coll. Mech.	...	6	...	8	...	10	...	5*	...	3*	...	8	...	4**	...	3	47
Flyash Coll. Elec.	...	...	...	2	...	...	...	3	...	2	...	1	...	2	...	8	18
Stage Bleeding	...	15	...	19	...	18	...	11	...	9	...	13	...	6	...	15	106
Steam Reheat	...	...	...	...	...	2	...	3	...	...	...	1	...	1	...	2	9
Cooling Tower	...	6	1	8	...	3	...	2	...	...	...	1	...	...	...	...	21
Dupl. Feed Pump	...	15	...	20	...	16	...	10	...	10	...	10	...	5	...	11	97
Dupl. Circ. Pump	...	9	...	13	...	10	...	9	...	7	...	9	...	6	...	11	74
Gen. Air Cooler	...	12	3	11	3	12	4	3	5	4	4	3	4	1	11	4	84
Gen. Hydr. Cooler	...	1	3	7	3	3	4	2	5	1	4	6	4	...	11	...	54
Switchyard	...	16	...	15	...	17	...	8	...	6	...	12	...	6	...	13	93

* One plant has both mechanical and electrical

** Two plants have both mechanical and electrical

Economizers are provided in somewhat fewer plants, actually 71.

Boilers have been placed outdoors, wholly or partly, in 12 of the plants and these are all smaller than 75 megawatt.

Waterwalls are part of some or all of the boilers in 102 of the plants enumerated.

Automatic combustion control is a feature of 78 of the plants although not applied to all boilers in all instances.

Flyash collection is dominantly mechanical, 47 of the plants reporting mechanical flyash collection and 18 electrical precipitation. The electrical installations outnumber the mechanical only in the very largest plants. These are largely in metropolitan areas. A few plants have both forms.

Turbine bleeding for feed heating is almost universal, being reported for 106 of the plants.

Reheat of the steam at the boiler after passing partway through the turbine is still quite rare, being practiced in only 9 of the plants. Nor are these recent plants. However the high cost of fuel has recently revived interest in this measure of thermodynamic economy.

Reheat of the steam at the boiler after it has given up some of its energy in the turbine is a promising and profitable way of using fuel heat efficiently and advantageously. Most fortunate about this technical trick is that the saving in fuel can pay as neat a return as 23 to 24 percent on the added investment in turbine, boiler, piping etc. To approach the problem, assume a 62.5/75 megawatt plant operating at 61 percent load factor and consuming fuel that costs 34 cents per million Btu. Such a plant operating at 1250 psi and 950F will be burning $1,500,000 worth of coal and should be attaining a thermal economy of approximately 11,000 Btu per net kilowatt-hour.

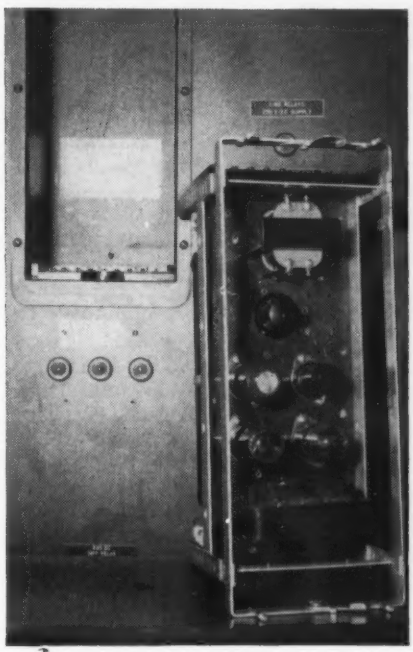
A 2.6 percent better job could be done by adopting 1450 psi and the 1000 F temperature since justifiable (1050 F has been chosen for some recent plants). Of this gain, 1.1 percent can be attributed to the higher pressure and it is not likely that either the boiler or turbine will be appreciably more expensive on this account. The other 1.5 percent is attributable to the higher temperature and this may entail a $50,000 greater outlay for the turbine and $80,000 for the boiler. But the efficiency should advance to 10,715 Btu, carrying the fuel expenditure down to $1,460,000. The annual saving of $40,000 returns about 30 percent on the incremental investment. That is why it is being done.

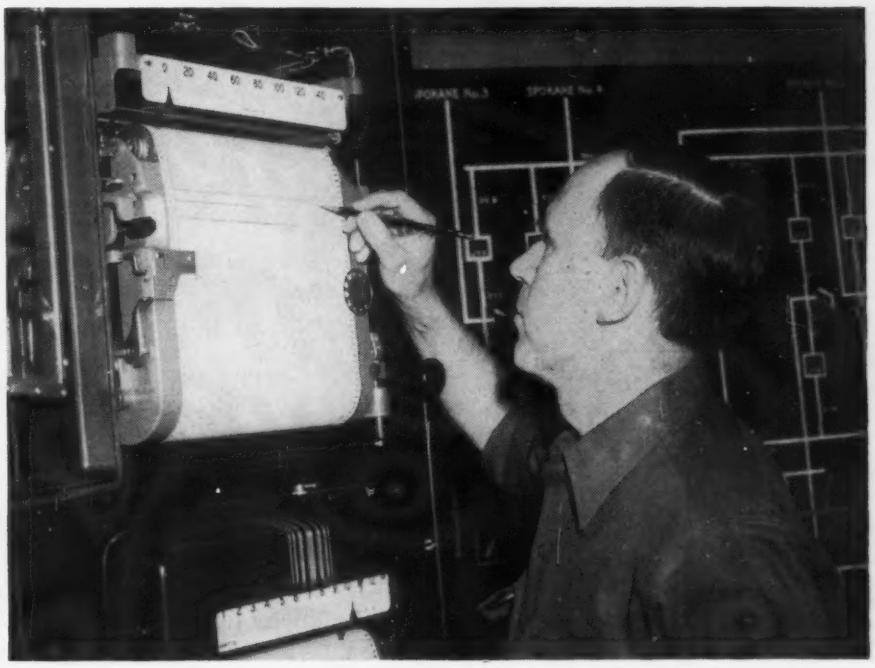
But an equally attractive contribution can be obtained from tapping off the steam after it has dropped to the 600 F point in the turbine and passing it back to the boiler for restoring its state to 1000 F by impartation of the requisite heat energy. The 5 percent betterment thermodynamically achievable should bring the Btu per kilowatthour down to 10,185 and the fuel bill down to $1,385,000. The dollar saving against the "once-through" 1250/950 cycle is $115,000 a year. Probably the boiler and turbine may each cost $225,000 more. There will be more piping but it can be assumed that its cost will be offset by less expensive pumps and condenser. So there is an added $75,000 to pay a further return of 23.5 percent on the $320,000 added outlay to outdo the mere upping of temperature and pressure by reheat.

It is this sort of thinking which undoubtedly accounts for the ten or more commitments understood to have been made already this year for reheat plants to be functioning early in 1951.

Reprints of this report are available at 35 cents each in lots of one to fifty, and 30 cents each in lots of fifty or more. Address the Editorial Department, ELECTRICAL WORLD, 330 West 42nd Street, New York 18, N. Y.

HOW TO DESIGN • CONSTRUCT OPERATE • MAINTAIN





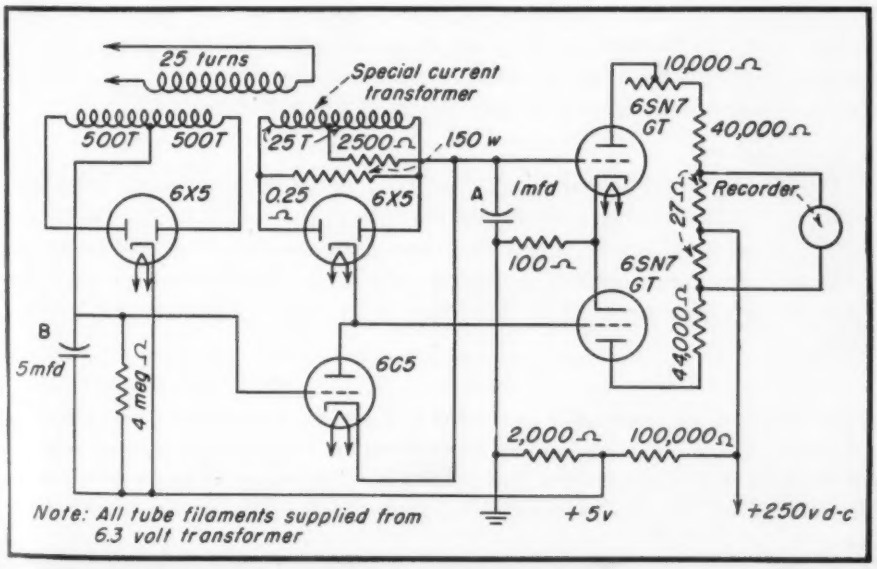
ELECTRONIC transmission line fault current recorder (left) is mounted in standard relay frame for easy installation and inspection. It operates standard load recorder (right); pencil points to longest line on typical chart showing fault current of about 2,750 amp

Simple Electronic Fault Recorder

LENARD R. ENGVALL
Electrical Engineer
Grand Coulee Dam Power Plant
Coulee Dam, Washington

AN ELECTRONIC fault current recorder has been in successful operation at Grand Coulee power plant for over two years. This automatic device records transmission line fault currents immediately and accurately.

The device consists of two units. One is basically a vacuum tube voltmeter, with output determined by charge on a condenser that is proportional to the current to be measured. Second unit is a conventional load recorder; but it can be any d-c recording instrument with a sensitivity matching the output of the first unit. For maximum benefits from the single installation it is connected into the transformer neutral circuit so it is affected by a ground fault on any line.



SIMPLE COMPONENTS comprise the electronic fault recorder

As shown in the connection diagram, the primary of a special 3-winding current transformer carries the current to be measured. A resistor, connected across the secondary, determines the voltage developed across each winding for any given current value. A type 6X5 vacuum tube rectifies part of the current flowing in this coil and charges the 1-microfarad condenser *A* in proportion to the primary current. The triode units in a twin-triode tube, type 6SN7-GT, operate in parallel. The potentials that their plate currents develop across identical resistors are normally balanced and applied to the recording

why it will pay you to specify

STANDARDIZED NETWORK EQUIPMENT

The a-c secondary network system is recognized as *the* lowest-cost system for providing high-quality service to heavy load areas. It is normally the most economical high-quality service system for business sections of cities—50,000 or more in population—and will frequently pay its way in smaller towns as well.

But—to realize the full savings possible with networks, you must use *standardized* network equipment.

FASTER DELIVERY. Invariably, G-E standardized network transformers and protectors can be supplied on shorter delivery. No special engineering is required—production facilities are set up to manufacture standardized units.

LOWER PRICE. G-E standardized network units are normally appreciably lower in price than non-standard designs.

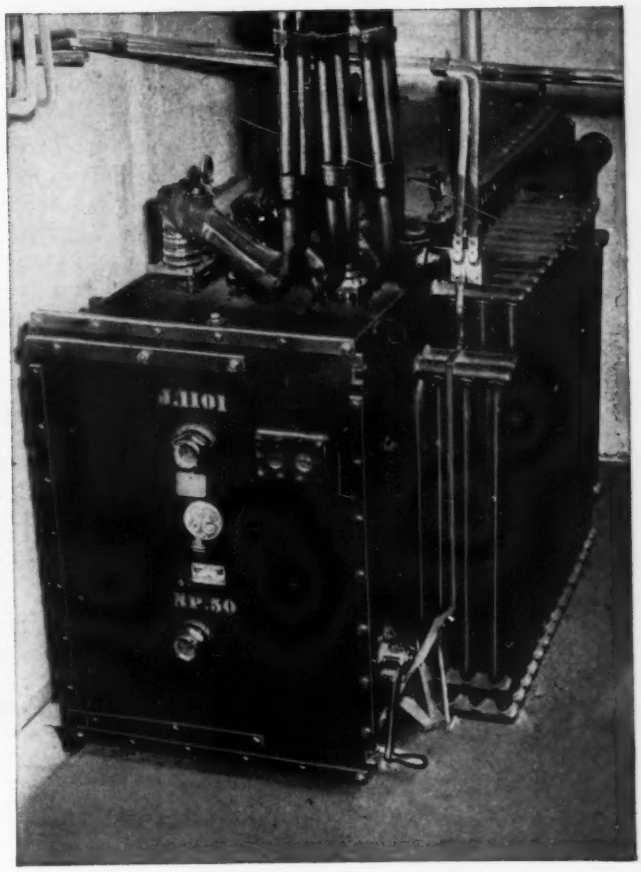
SUBSTANTIALLY LOWER INSTALLATION COSTS. G-E standardized network transformers and protectors are designed for a long, narrow vault. In length, width, overall height—and particularly in location of cable entrances, accessories, valve and filter-press connections—standardized equipments are of the most economical design from the standpoint of vault construction and installation costs.

SAVINGS IN MAINTENANCE. G-E standardized network equipment incorporates all the maintenance-saving developments which the industry recognizes as desirable. Transformer cover and switchbox are welded, not bolted, to the transformer—the tap changer is located behind a pipe plug. Thus major gaskets are not needed. Transformer accessories are grouped in one location for maximum convenience.

An inquiry to your G-E Representative or a letter to *Apparatus Department, General Electric Company, Schenectady 5, N.Y.*, will bring you information on standardized network equipment—and just what should be specified to secure the savings which this equipment makes possible. Bulletin GEA-5024 describes network transformers; GEA-2017, network protectors.

ALL THE FEATURES YOU NEED . . . NO COSTLY EXTRAS

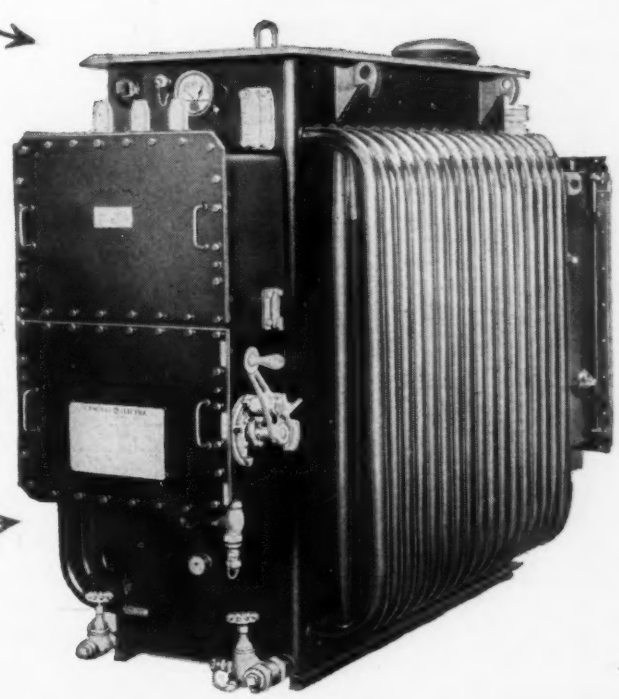
G-E standardized transformers and protectors include all accessories, all features, that the majority of users of network equipment have found desirable.



TOP CONNECTIONS OF TERMINALS, for both high- and low-voltage cables, are well below top of transformer, allowing room for larger radius bends of cables in shallower vaults. Maximum interchangeability between various sizes is also provided.

THE PHYSICAL SIZE AND ARRANGEMENT of G-E standardized network equipments mean minimum vault construction costs. These equipments are designed for vaults with widths of 4½ feet or less—vaults which can generally be built between building line and curb, and which reduce appreciably the problem of roof-slab construction.

AUTOMATIC SYSTEM PROTECTION is provided by the network protector which trips on reversal of power. When conditions are corrected, it recloses automatically. Protector case is submersible. With the door open, the protector unit can be slid out on rails for ready inspection. Dust-tight relays can be easily removed and replaced for checking.



MAJOR TRANSFORMER GASKETS ARE ELIMINATED by welding, not bolting, transformer cover and switchbox to the main unit. Locating tap changer behind a pipe plug eliminates a packing gland around an external shaft.

ALL TRANSFORMER ACCESSORIES—liquid-level gages, thermometer, pressure test valves, tap changer, drain valves, sampling valves and filter-press valves—are located at the high-voltage end of the transformer where they are readily accessible. Bushings themselves can be removed externally, without opening the main transformer tank.

THE HIGH-VOLTAGE SWITCH is a three-position disconnecting and grounding switch with electrical interlock to prevent operation when the transformer is energized either from the high-voltage or low-voltage side.

COOLING TUBES may have a wall thickness of 3/32 inch (vault-type) or of 5/16 inch (subway type). This is the only difference between the vault-type and subway-type transformers. The tank casing is made of a 5/16-inch plate. Both types—designed to withstand a full 7-pounds-per-square-inch, 24-hour pressure test—can be completely submerged without damage or interruption of service. Both types are protected by a superior G-E painting system, developed specifically for severe underground service.

GENERAL ELECTRIC

402-74

32¢ per gal and adsorbent at 5¢ per lb.

It should be noted in passing that the greatest improvement in neutralization number (acidity) will be obtained in the first oil passing through a given charge of new adsorbent. As successive amounts of oil pass the unit the improvement will be less. During the test the charge was charged when improvement in neutralization number approached zero. As a new charge was added, improvement in acidity was again resumed. But one of the purposes of the test was to determine the dosage to secure an acidity of 0.10. This dosage, found by test to be 0.65 lb per gal will be used in the field to determine how long the unit should operate at rating before a new charge is necessary.

During the test, oil was not heated before being treated because warm oil might drive moisture out of the adsorbent and into the oil at a sacrifice to dielectric strength. If it should become necessary to condition "hot oil" in the field it may be desirable to use a blotter type filter in conjunction with it to remove moisture.

The company is currently considering where needed, the reconditioning of oil in all major apparatus on the system. To avoid contaminating "clean" oil with sludge residue which might otherwise remain the plan is to sluice the tank and internal assembly with clean oil before refilling.

O.H. Line Estimating—IV
Foreman's Daily Reports

THEODORE H. GUCK*
Overhead Lines Dept
The Detroit Edison Co
Detroit, Mich.

OVERHEAD LINES department orders for construction and removal are given to the line crew foremen in the form illustrated, which supplements the bill of material previously outlined in this series. With this general description and the estimator's sketch the foreman also receives one copy of the labor unit estimate sheet.

If a change in the construction of the job is required, the foreman crosses out those units originally estimated and enters the corrected units. His copy is returned to the office clerk who enters any corrections on the original copy.

The line crew foreman's report of his work is carried on one daily sheet for his crew. Entries on this time report, supplementing his corrections on the bill of material and labor estimate sheet, becomes his full record for payroll, accounting and lines department use.

OVERHEAD LINES DEPARTMENT ORDER

LOCATION	CITY OF GARDEN CITY Elmwood and Dillon.
GENERAL DESCRIPTION	Install 3 poles, 3 sections of secondary, and 1 transformer. Remove 1 transformer, 2 sections of primary. Replace 3 sections of primary.
REASON	Rearrange distribution to permanent position in conjunction with new business extension.
DEPT ORDER NO.	M-25849
MAP SECTION NO.	Nan 9-3
WAREHOUSE	Ecorse Road
DATE WANTED	
E & R REPORT NO.	
EBO NO.	
DATE ISSUED	9-6-46

*J. U. TERM *TREE TRIM *SHUT DOWN *OUTSIDE CREW ACTUAL
*J. U. PERMIT *PORSION ATTACH *RR X-ING BB & CONCRETE BREAK PAVEMENT *MISC PERMIT STAKED ESTIMATED

NOTE TO FOREMAN: DISTRIBUTE LABOR TO WORK ORDERS INDICATED	DISTRIBUTION WORK ORDER	TRANSMISSION WORK ORDER	STREET LIGHTING WORK ORDER	SYSTEM COMMUNICATION WORK ORDER	MISCELLANEOUS WORK ORDER
INSTALLATION OF POLES AND POLE MATERIAL	35LA3J2				
INSTALLATION OF CONDUCTOR AND MEMO MATERIAL	35SA4J2				
INSTALLATION OF STREET LIGHT FIXTURES					
INSTALLATION OF SERVICE MATERIAL					
REMOVAL OF POLES, POLE MATERIAL, MEMO. CONDUCTORS	57489				
TRANSFER OF POLE MATERIAL, MEMO. CONDUCTORS	57489				
REMOVAL OF SERVICES					
TRANSFER OF SERVICES	4801				
TREE TRIMMING					
OPERATION					

*SKETCH BELOW
Dist. Cir. #301 Garden City
Sketch attached.
Do in conjunction with D.O. # S-25850.

WORK DESCRIPTION FORMS (above) have a sketch on reverse side for issue to the line foreman. One daily time report (below) gives the complete record required

DAILY TIME REPORT

TRUCK NO. B-968 DIGGER NO. —
TRAILER NO. F-284
DATE Oct. 11, 1946
SHIFT TIME 8:00 A.M. TO 4:30 P.M.

FOREMAN	ACTUAL	ADDITIONAL	ABSENT	TRUCK CARE	EXTRA TIME FOR ACT. PER. HR.	TOTAL	OVERTIME START	OVERTIME FINISH	ELAPSED TIME LUNCH PERIOD START	LUNCH PERIOD FINISH	LUNCH PERIOD MIN	NO. OF MEN	DRIVING TOTAL MIN	X TIME TOTAL MIN	TRUCK BREAKDOWN INC WEATHER TOTAL MIN	TIME CHARGEABLE TO DEPT ORDER OR WORK ORDER TOTAL MIN	DEPT ORDER OR WORK ORDER NUMBER	DESCRIPTION OF WORK ACCOMPLISHED
									12:00	12:30	30							
									START	FINISH	MIN		TOTAL MIN	TOTAL MIN	TOTAL MIN	TOTAL MIN		
H. Coyle	8					8			8:00	8:30	30	8	240			2040	M-25849	Elmwood and Dillon - Garden City Inst. 3 sec. of Sec. removed transformer 3 kva. #17284 and inst. 5 kva. transformer #14897
R. Johnson	8			¼		8¼	7:45	8:00	1:15	1:30	15	8	120					Removed 2 sect. of primary and replaced 3 sect. of primary.
W. Thompson	8			½		8½	4:15	5:00										
J. Roberts	8					8			1:15	1:30	15	8	120				0-25817	
																600	48 B1	Straightened 2 poles and replaced 2 - 96" x arms.
									COLUMN TOTALS			480				3360		
TOTAL HOURS	64			3/4		64 3/4												
TOTAL MINUTES						3885												

SUMMARIZED BY _____ CHECKED BY _____ POSTED BY _____
FOREMAN'S SIGNATURE _____
APPROVED _____

* Last of a series begun in EW, May 22, 1947, p 146

unit. Any voltage appearing across condenser *A* is applied to the control grid of one triode, upsetting the balance and causing the recorder to move off zero.

A fault is usually cleared in a few cycles; but the voltages built up by the fault current must be maintained long enough for the instrument to stabilize. After operation the device must quickly reset itself to zero for the next operation. This is done by an auxiliary winding on the current transformer feeding a rectifier tube that changes the 5-microfarad condenser *B*, which applies a high negative voltage to the control grid of the 6C5 tube.

The 6C5 tube discharges condenser *A* when its grid potential approaches its cathode potential. Therefore, voltage on *A* is maintained substantially constant until the charge on *B* is bled off; then the voltage on *A* quickly drops to its normal value. Time delay is determined by the condenser-resistor combination that is designed to match the recorder.

At Coulee Dam an oscillograph was used to calibrate the instrument. Test currents were put through the primary of the current transformer and were interrupted after few cycles to simulate fault conditions. As shown in the schematic, current charging the condenser *A* flows through a 2,500-ohm resistor. This resistor tends to compensate for offset currents because it prevents normal charge from being reached until about the fifth cycle. On this basis, if fault current is interrupted in 3 cycles, registration will be about 3% low; if it continues for 9 cycles, registration will be 2.5% high, and for 30 cycles, about 6% high.

During the two years that the instrument has been used at Coulee Dam, no re-calibration has been necessary. Maintenance costs have been only the replacement of one vacuum tube. With a few exceptions, the values obtained with the recorder have checked very closely with those recorded by an automatic oscillograph. All parts for the device can be easily obtained and assembled.

Adsorbent Dosage For Oil Estimated by Test

IN REVIEWING practices used on its system for conditioning insulating oil, Pennsylvania Power & Light Co, Hazleton, recently explored the merits of adsorption type conditioning equipment of the Fuller's earth type. Objective of the study was not only to find the effect of such treatment on acidity, interfacial tension, color and power factor but also to determine the cost of conditioning, the adsorbent dosage required to obtain proper reconditioning and the amount of oil lost in the process.

	Neutralization Number	Interfacial Tension-Dynes	Color	Power Factor	Dielectric Strength-Kv
Before.....	0.60	15.5	4.5	0.47	30
After.....	0.10	38.8	2.5	0.00	30

OIL CONDITIONING EQUIPMENT of the adsorption type used in test comprises two 450-gal per hr units each containing 200 lb charge of Fuller's earth. Units can be operated in tandem or parallel or individually by-passed by means of piping arrangement. A 10-gpm pump circulates the oil. Davit is for handling charge

In the course of the study a test was made in which 2,685 gal of badly-contaminated, unheated oil was run through two adsorption units arranged in tandem. Each was rated at 450 gal per hr and carried a 200 lb charge of adsorbent. Oil was forced through the units by a motor driven pump rated 10 gpm. Heating units were available in the units to warm the oil but they were not used.

The test run was continuous, being carried on for 30 hr before neutralization number dropped to 0.10. No break in the test was necessary since by-pass piping let operators renew the adsorbent charge in one unit while the other unit continued to operate.

Condition of the oil before and after conditioning is summarized as shown in accompanying table.

A total of 1750 lb of Fuller's earth was used in reducing neutralization number of the 2,685 gal to the desired value of 0.10. Dosage was therefore 0.65 lb per gal. About 10% of the oil was soaked up and lost in the adsorbent medium or about 1.1 lb of oil per lb of adsorbent.

Considering labor time and material only, the cost of conditioning oil was estimated as about 25% of the cost of new oil assuming oil cost of

Now! for improved service continuity and reduced operating costs on rural lines

the new FR-1 relayed AUTOMATIC RECLOSER

Here are the FEATURES . . .

1 **CHOICE OF *TWO* OPERATING FUNCTIONS . . . (convertible in the field).** (a) *Two instantaneous openings plus two time-delay openings to lock-open* — permitting an exceptionally wide range of co-ordination with a large number of fuses, due to specifically designed time-current characteristics. (b) *Two instantaneous openings to lock-closed* — permitting an extended range of co-ordination with fuses; i.e., co-ordination over an even greater range of current values.

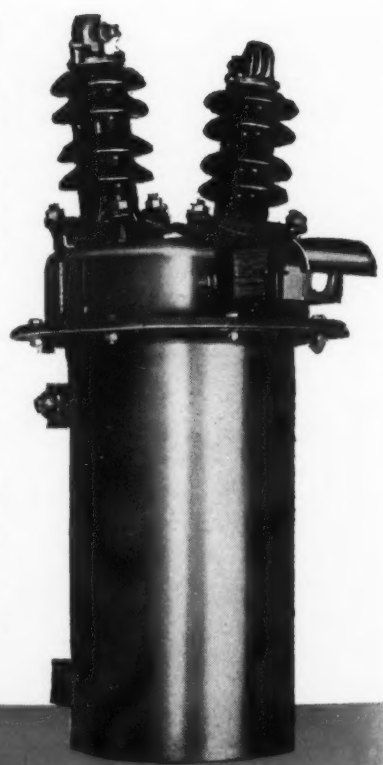
2 **AN ACCURATE *MECHANICAL-ESCAPEMENT* TIMER** . . . Precision timing, virtually *unaffected by changes in ambient temperature*, assures an unprecedented reliability of co-ordination of recloser-to-recloser and recloser-to-fuses, regardless of season.

3 **EXCEPTIONALLY FAST RE-SETTING TO INSTANTANEOUS TRIPPING** — enables clearing of rapidly recurring non-persistent faults which otherwise would cause unnecessary blowing of series fuses.

4 ***RELAY CONTROL* OF MAIN INTERRUPTER CIRCUIT** . . . Uses proved circuit-breaker principle; reduces forces on operating mechanism and achieves more accurate time-current characteristics; eliminates chattering of contacts and assures long life.

5 ***OIL-BLAST* INTERRUPTER** . . . Longer contact life, with minimum carbonization of oil, results from fast arc-extinction by same type of double-break Elkonite contacts and oil-blast interrupter used in all large G-E oil circuit breakers.

PLUS **ELEVEN OTHER IMPORTANT ELECTRICAL AND MECHANICAL FEATURES** that bring maximum freedom from inrush-current lockouts, and that simplify installation, increase safety, prolong operating life, and minimize maintenance.



Bulletin GEA-4934 gives full data, including ordering information. Ask for it today from your nearest G-E Apparatus Office or write *Apparatus Dept., General Electric Company, Schenectady 5, N. Y*

CONTINUOUS RATINGS	5, 10, 15 25, 35, and 50 amperes
INTERRUPTING RATINGS	25 times continuous rating
MINIMUM PICK-UP CURRENT	2 times continuous rating
FOR APPLICATION ON CIRCUITS	2400 to 15000 volts

CUTS CONSUMER OUTAGE TIME...REDUCES TROUBLEMAN TRIPS

The new FR-1 Relayed Automatic Recloser is a distinctive G-E development.

Its exclusive dual-slope time-delay curve, negligible variations of timing mechanism, and freedom from effects of ambient temperatures, make it functionally superior for modern overcurrent protection.

More Reliable Co-ordination

Now, time-current characteristics stay put—remain accurate regardless of season.

The new FR-1 recloser employs a mechanical-escapement timer that is unaffected by changes in ambient temperature. It uses a relay to control, more accurately, the opening of the main interrupter.

Together, these features give a precision of time-current characteristics never before achieved. Co-ordination remains reliable, the year 'round; false operations are eliminated; there are fewer outages, and fewer service trips.

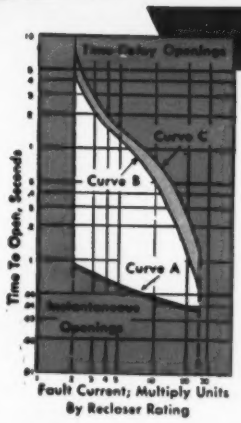
Wider Range Co-ordination

Now, co-ordination can include sectionalizing, branch-line, and transformer external or internal fuses—individually or all in series, with each recloser.

With the conventional operation—see below—it can be reliably co-ordinated with many different fuse ratings. This is because of the recloser's dual-slope time-delay curve and the year-round accuracy of its overall characteristics.

With the extended-range co-ordination operation—see below—it introduces an entirely new concept of recloser-fuse co-ordination. Here, isolation of persistent faults is accomplished entirely by co-ordination of fuses—and an even greater number of fuse ratings can be used in series with each recloser.

HERE IS THE CO-ORDINATION STORY



WITH CONVENTIONAL OPERATION—2 instantaneous plus 2 time-delay openings—a combination which has proved most efficient for minimizing the number and duration of system outages.

1 & 2—Two instantaneous openings.

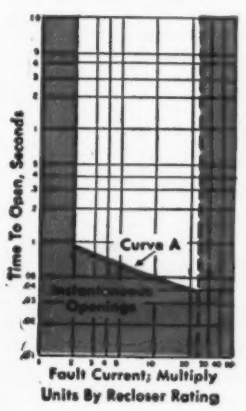
The 1st and 2nd openings are fast, with 1-second to reclose after each. Recloser will *always* trip at or below curve "A" of the chart at left, clearing all non-persistent faults with only a momentary outage, and without even partially melting fuse links coordinated with recloser.

3 & 4—Two time-delay openings.

The 3rd and 4th openings are slow, with 1-second to reclose after the 3rd opening and lock-open after the 4th. Recloser will *always* open within the upper band (between curves "B" and "C") of the chart at left, *regardless of ambient temperature.* The wide area, between Curve "A" and Curve "B" is available for reliable co-ordination of load-side fuses, permitting a choice of fuse ratings that will limit persistent faults to a minimum portion of the circuit.

5—Lock-open

Persistent faults between reclosers or between recloser and nearest load-side fuse will cause the recloser to lock open, and remain open until manually reclosed. The lock-open operation does not interfere with source-side protection because the area above Curve "C" permits reliable co-ordination with source-side fuse or circuit-breaker.



WITH EXTENDED-RANGE CO-ORDINATION OPERATION—2 instantaneous openings plus unlimited time-delay until automatic resetting—a combination extending series co-ordination with fuses, which minimizes the extent of consumer outage.

1 & 2—Two instantaneous openings.

The 1st and 2nd openings are fast, with 1-second to reclose after each. Recloser will *always* trip at or below Curve "A" of the chart at left, clearing all non-persistent faults with only a momentary outage, and without even partially melting fuse links co-ordinated with recloser.

3—Lock-closed

After the two instantaneous openings, the recloser locks closed. This introduces, in effect, an unlimited time-delay (until automatic resetting)—with persistent faults isolated entirely by co-ordinated fuses.

As shown in the chart at left, the area for co-ordination of recloser with both load-side and source-side fuses extends upward from Curve "A" *with no upper limit,* since there is no time-delay tripping characteristic. This function permits a maximum number of fuses to be co-ordinated in series with each recloser, thus increasing the number of available sectionalizing points.

4—Automatic reset

Immediately after a fuse has isolated the persistent fault, the recloser automatically resets. Service is restored and maintained everywhere except beyond the blown fuse.

GENERAL ELECTRIC

Penstock Diameter For Hydraulic Turbines

Chart has been developed to give economical pipe diameter (average) for high-head and medium-head power plants. The scale range for head is from 300 to 12,000 ft

EXAMPLE FOR USE OF CHART

Given:
Head = 1,000 ft
Capacity = 1,000 cfs

Find:
Penstock diameter
Velocity of water in pipe

Solution:
Lay a straight edge across the scales at points 1000-ft head and 1000-cfs capacity.

Read pipe diameter 8 ft on right hand scale and velocity 22 ft per sec on second scale.

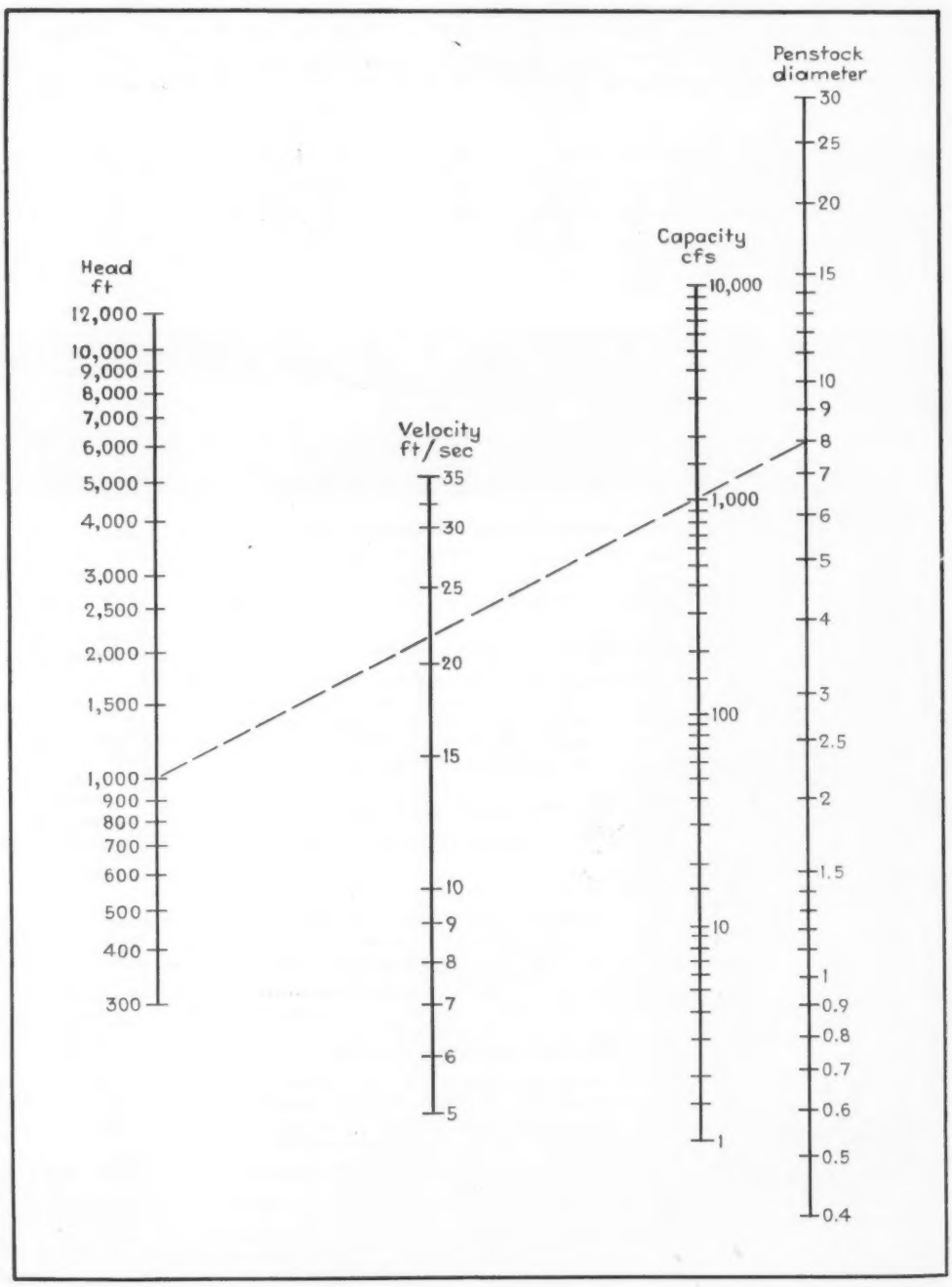
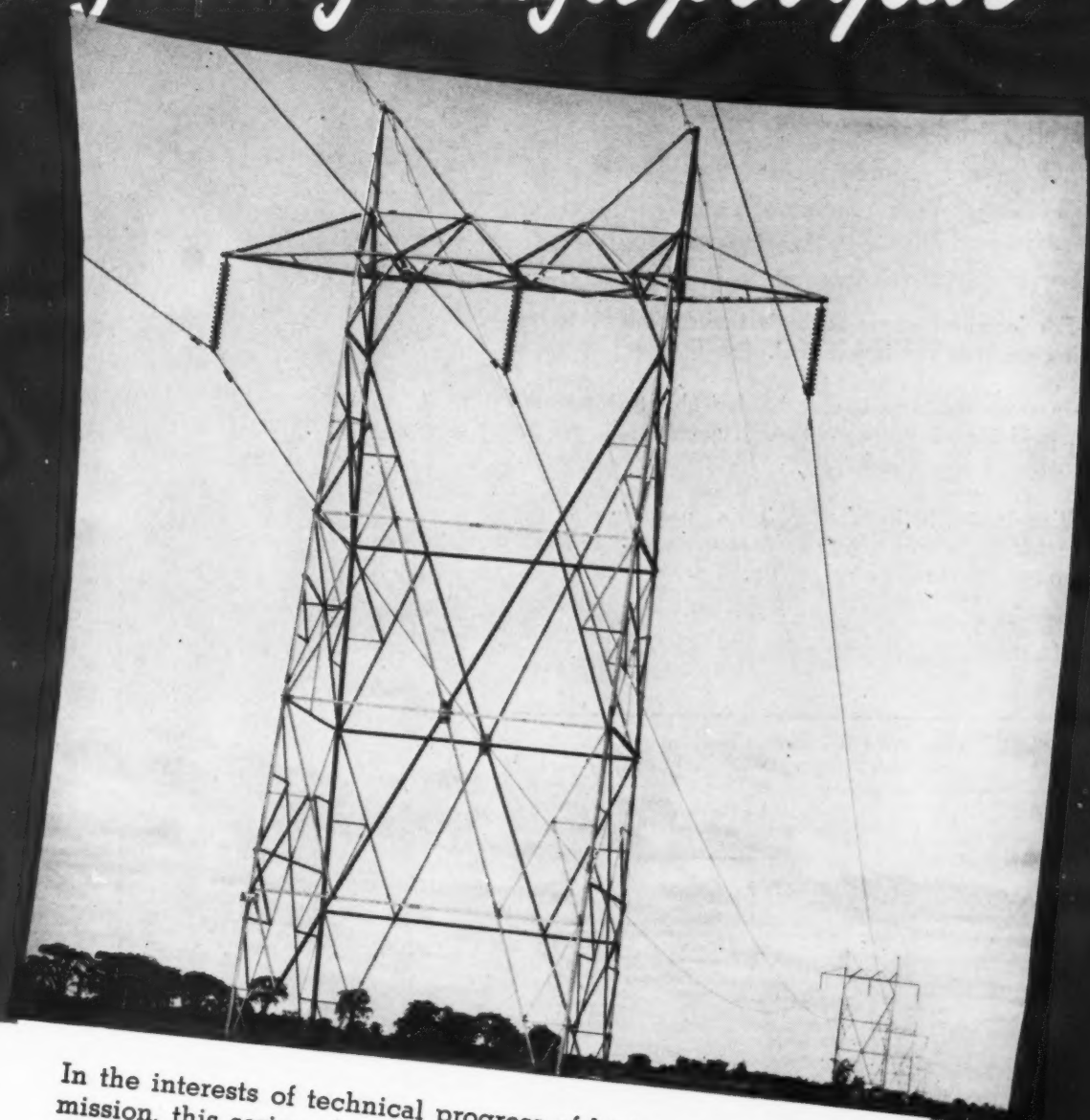


Chart by Ludin: Wasserkraftanlagen, Berlin, 1934; converted from metric system by H. W. Hamm, Design Engineer, S. Morgan Smith Co, York, Pa.

Hydro-Electric Power Commission Two lightning outages per Year



In the interests of technical progress of high-voltage transmission, this series of operating reports is presented to the Electrical Industry. As a manufacturer of insulators and hardware, the Ohio Brass Company is vitally concerned in this development. These reports and many others will soon be compiled in book form and made available to power company engineers.

2855-H

Ohio Brass

MANSFIELD, OHIO

Canadian Ohio Brass Co., Ltd., Niagara Falls, Ont.

Sidewalk Guy Installation

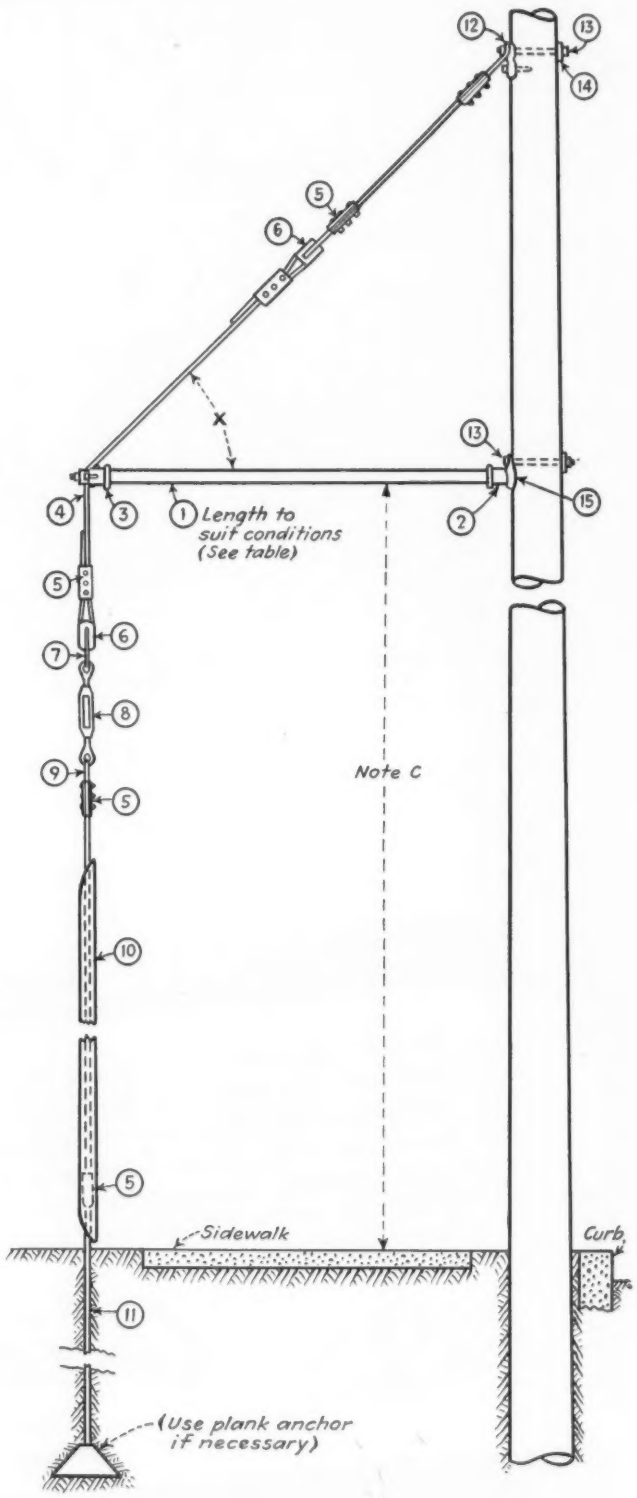
Details adapted from Overhead Construction Standards of New England Electric System, Boston, Mass.

NOTES

A—For locations where space is limited and preferred guying methods are impractical.

B—In some locations it may be desirable to locate the anchor inside of property line, if permission can be secured.

C—Pipe arm to be installed as low as possible (but not lower than 10 ft over sidewalk) to lessen bending of pole at point of attachment of pipe arm.



Guy And Horizontal Tension

(For Angle X Not Less Than 45 Deg)

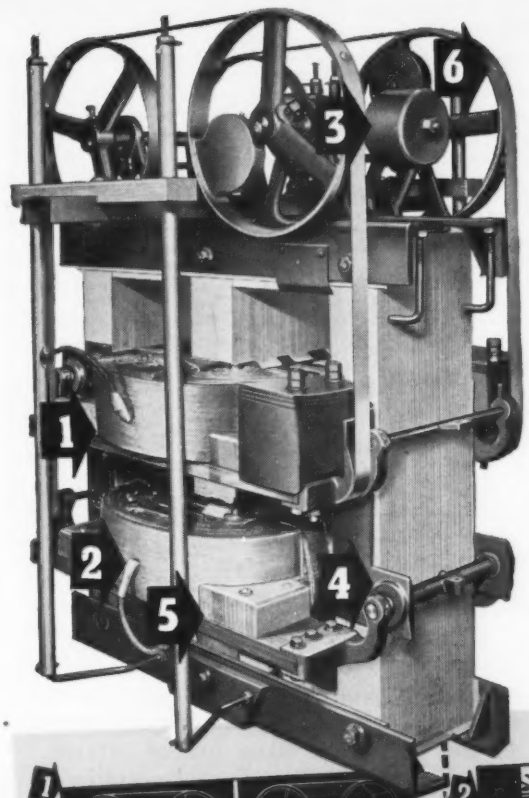
Guy Stand	Maximum Horizontal Tension (lb) which can be supported at height of 30 ft		
	6-ft pipe arm	8-ft pipe arm	10-ft pipe arm
3/8-in., 7 str.	990	1320	1650
7/16-in., 7 str.	1560	2080	2600

If point of support of horizontal load is over 30 ft in height, decrease values fo tension shown in table in proportion to increase in height.
If point of support of horizontal load is less than 30 ft in height, increase values for tension shown in table in proportion to decrease in height.

List of Material

Item	Description
1	Pipe, galvanized, 2 in.
2	Sidewalk pole fitting, 2 in.
3	Sidewalk guy clamp, 2 in.
4	Guy wire
5	Guy clamp, 3-bolt
6	Guy insulators
7	Guy insulator clevis
8	Turnbuckle, 5/8 in. x 9 in. min.
9	Guy thimble, 1/2 in.
10	Guy wire protector
11	Std anchor installation
12	Std pole attachment
13	Through bolts, 5/8 in. (*)
14	Square washers, 13/16 in. x 21/4 in
15	Lag screws, 1/2 in. x 3 in.

(*) Length as required



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Constant Current
TRANSFORMERS

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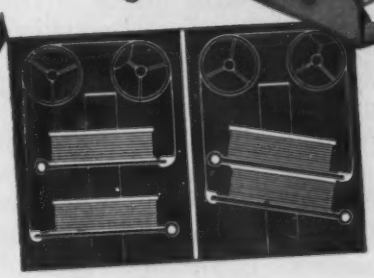
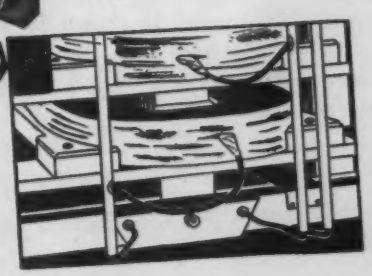
CHECK THESE SUPERIOR FEATURES ✓ ✓



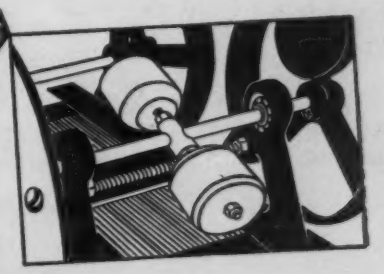
Double Moving Coils

Each coil moves one-half the distance of the single moving coil in ordinary regulators. Normal secondary current is attained quicker upon load changes or primary surges, with coils parallel throughout operation. Lower kinetic energy practically eliminates force on bumpers during short circuit.



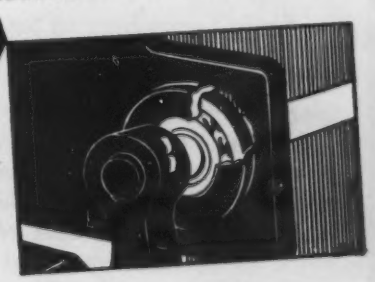
Extra-Flexible Leads

Extra-flexible cable is used for leads to prevent sluggish movement of the coils and to avoid service interruptions due to lead breakage. To protect and support them, leads are brought up to the terminals through heavy insulating tubes which are firmly anchored at both ends.



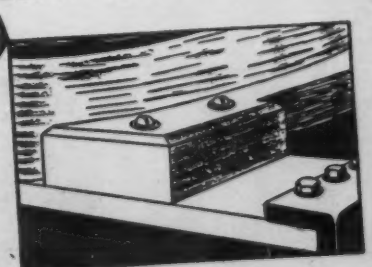
Adjusting Weight

The adjusting weight is mounted at the top on the shaft of one of the pulley wheels. It is arranged with a vernier for accurate and accessible adjustment. After adjustment is made, the weight is securely locked in position at the factory to deliver constant rated current. No adjustment is necessary when installing.



Ball Bearings

All moving parts are fitted with precision ball bearings to eliminate friction. The coils are hinged on ball bearings, the primary at one end and the secondary at the other. Hinge points are rigidly fixed by metal plates bolted to the core.



Coil Mounting

The supports on which the coils are mounted are designed to withstand impact between the coils themselves and impact between the coil supports and the bumpers, under the most severe operating conditions. Coils are rigidly blocked on the supports to maintain accurate alignment.

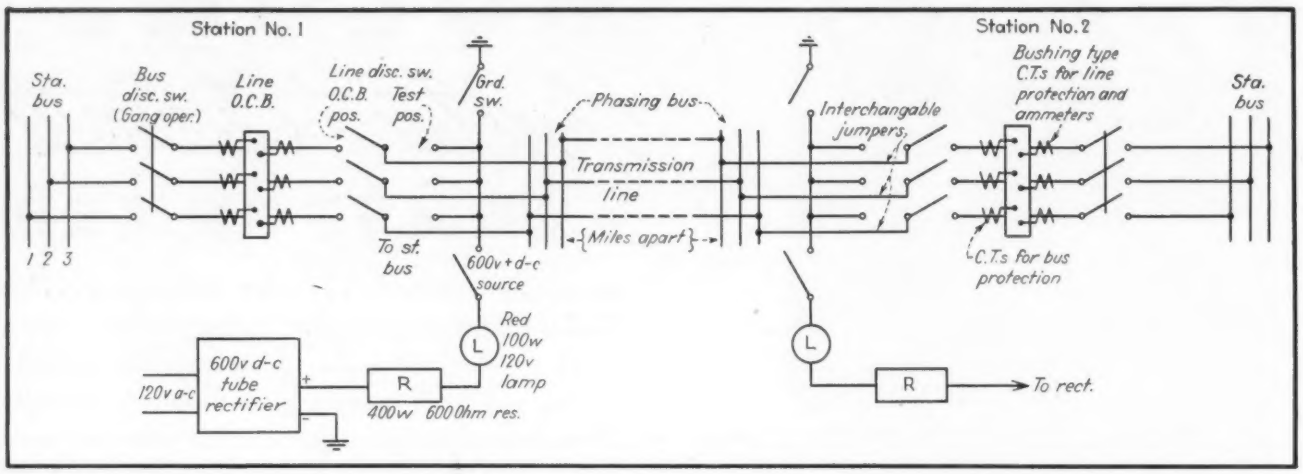
Stainless Steel Bands

Corrosion-proof stainless steel bands are securely fastened to the moving ends of each coil and to the pulley wheels to hold the coils parallel for the complete range of operation. These stainless steel bands last indefinitely.

Send for bulletin SL-701 describing Moloney Constant Current Transformers

MOLONEY ELECTRIC CO. ☆ ST. LOUIS 20, MO.

POWER AND DISTRIBUTION TRANSFORMERS EXCLUSIVELY SINCE 1896



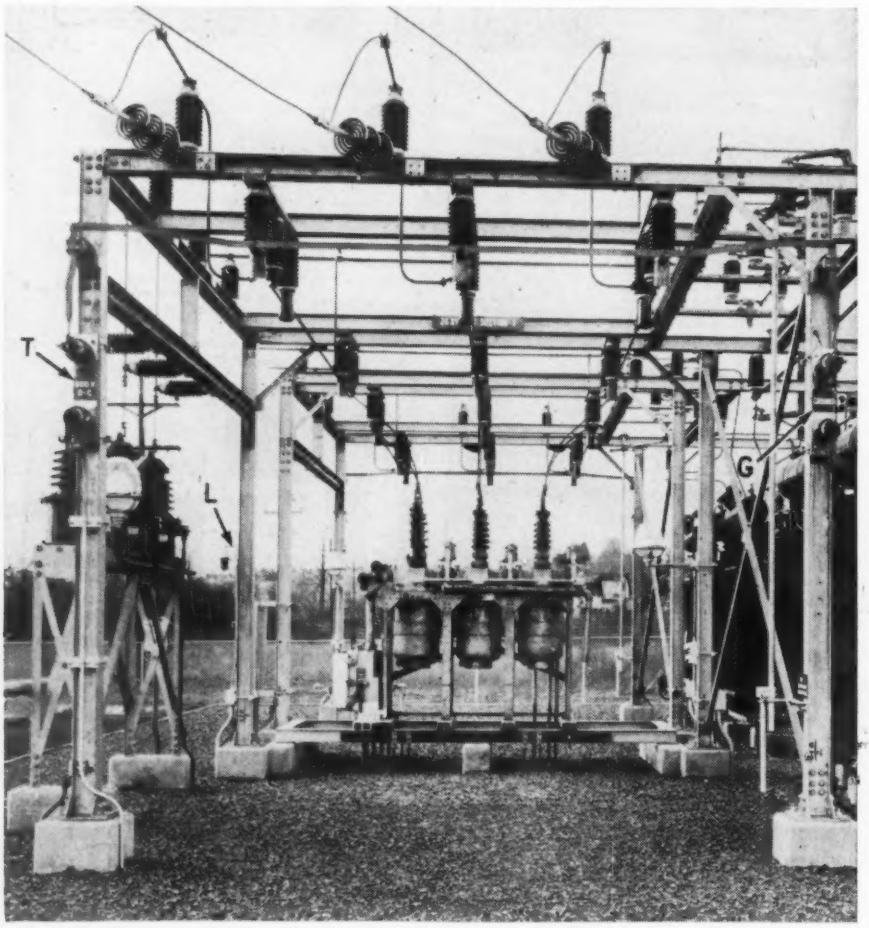
TEST EQUIPMENT and transmission line connections

Procedure for Testing Transmission Lines—I

ROLAND R. RHODES
Relayman
Public Service Electric and Gas Co.
Hackensack, N. J.

A STANDARD METHOD outlined here covers phasing and continuity testing of 13 and 26-kv transmission lines. It was developed by the Public Service Electric and Gas Co, Newark, N. J., has been in use for a number of years and has proved satisfactory. Arrangement of the station and test equipment is shown in the connection diagram. An illustration shows lamp and test switch mountings.

1. *Test Operations after Removing a Line from Service.* A definite procedure for the protection of personnel is followed when clearing up, grounding and short-circuiting a transmission line taken out of service for "work." Coordinated operations are carried out at both ends of the line and are under orders of the load dispatcher.



MOUNTING of testing equipment: L=100-w lamp, T=spst 600-v d-c source switch opened, G=spst ground switch closed to test bus

The oil circuit breaker (OCB) is opened at Station 1, followed by the opening of the OCB at Station 2. The OCB's are checked for open position as a safety precaution by:

(a) Zero readings on the line ammeters.

(b) Lighting of the green light on the line control panel.

At Station 1, the main bus disconnecting switches are opened but only after the following additional safety precautions are taken:

(c) Checking the position of the mechanical semaphone on the operating mechanism at the line breaker.

(d) Operating the manual emergency trip on the line breaker.

At Station 2, the main bus disconnecting switches are opened after checks (c) and (d) are made at the breaker. The line is then carefully tested for absence of potential with a neon tube test stick. If clear of potential, the line disconnecting switches are opened from the OCB position and closed to the test bus position. The test bus ground switch, which is normally closed, is checked to make sure that it is closed. This completes the operations at Station 2.

At Station 1, checks (c) and (d) are made at the breaker. The line is then tested for absence of potential. If clear of potential, the line dis-

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More Power To You!

...or how it is possible for you to increase your present Power Plant Capacity!

One of the most important components of a power plant is the draft producer, yet, in many plants today, this part of the equipment is purchased from widely separated sources, with no thought of coordination between breeching, fan and stack.

Mechanical efficiency of the draft producer is not determined exclusively by the induced draft fan; but must be attained by proper correlation of all three major units upon which draft is dependent . . . Fan, breeching and stack. And who should be responsible for proper integration? *Not* the plant design engineer. Indeed, the responsibility belongs to the *manufacturer* who makes this equipment. His specialized know-how, weighed against prevailing conditions and needs, will invariably come up with the right answer.

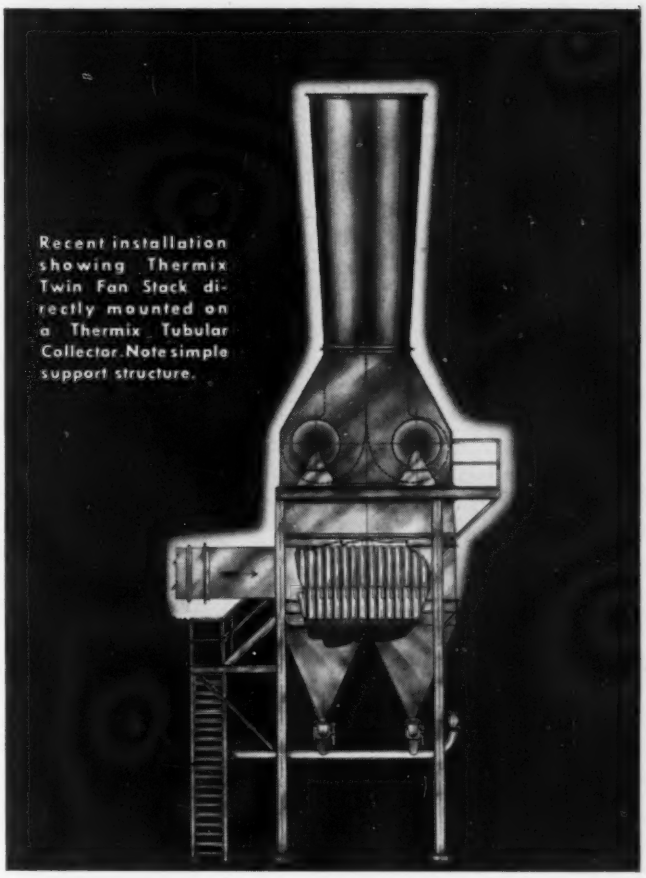
The ideal draft producing equipment source then, is one that relieves the plant design engineer of all responsibility for predetermined draft efficiency. To attain this, it is important that all three parts of the producing equipment (breeching, fan and stack) be designed, engineered and manufactured as a complete unit, guaranteed to a predetermined efficiency by one company.

It is highly important therefore, that the company offering such an apparatus should have a background, in the design of draft producing equipment, that will enable it to cope with any contingency related to this problem. Wherever possible, breeching bends and their inherent losses should be eliminated or reduced to a minimum. Proper design of the induced draft fan is necessary to adequately cover a fluctuating load. The stack should be designed to utilize the advantage that is afforded by conversion of dynamic energy of motion to static pressure, necessary in an efficient draft producer.

Introduction of the Thermix Fan Stack has enabled modern steam power plants to simplify this problem of induced draft. It has also relieved the plant designer of responsibility for the efficiency of this part of the installation. Thermix Fan Stacks offer the modern answer to the need for a complete draft producing, integrated unit, designed, engineered, manufactured and guaranteed by one company, The Prat Daniel Corporation.

Thermix Fan Stacks were developed over twenty-five years ago. During that time the constantly increasing development of more steam per square foot of boiler heating surface has resulted in higher draft requirements, with a consequent replacement of natural draft chimneys by mechanical draft.

These stacks offer a packaged coordinated apparatus for boilers ranging from 100,000 lbs to 1,000,000 lbs and over, consisting of breeching, fan and stack, ready for



Recent installation showing Thermix Twin Fan Stack directly mounted on a Thermix Tubular Collector. Note simple support structure.

installation directly on the boiler wherever possible. Reduced weight of the Thermix Fan Stack allows savings in steel when a separate mounting structure is required. When mounted directly on the boiler, Thermix Fan Stacks provide a direct outlet to atmosphere, with no breeching bend losses, and offers the most efficient draft producing equipment available.

Thermix Fan Stack and Thermix Collectors form the perfect combination for the control of fly ash and draft. When used in combination it is possible to utilize the same structural supports for both, by mounting the stack directly on the Thermix Dust Collector.

Thermix Tubular Collectors, Thermix Duplex Collectors and Thermix Series Collectors offer the ultimate in dust control and complete the integrated designs for complete control of gases from boiler outlet to atmosphere.

Further information on these important contributions to higher efficiency may be obtained by writing our project engineers:

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Baxco Long-Life Poles are strong, straight, machine shaved, Coast-type Douglas Fir pressure treated with creosote and pentachlorphenol to resist rot, termites and deterioration.

You'll be proud of these poles in your line and more than satisfied with their long maintenance-free service. Write or wire us your inquiries.

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connecting switches are opened and tests are made to check for proper grounding at the other end of the line. The test equipment is first checked to insure that it is in the proper operating condition. With the SPST ground switch closed, the 600-v d-c source is connected to the test bus by closing its SPST switch The standard 100-w lamp (in series with the test source) lights up, indicating that the test circuit (including the test bus) is in good operating condition.

The next operation is to open the ground switch which breaks the testing circuit by removing the ground from the test bus and extinguishing the test lamp. Phase 1 line switch is closed to the test bus. If the lamp lights, it indicates that that phase is properly grounded at the other end. The switch is then opened and similar tests are made for phases 2 and 3.

When the tests have been completed, all three line switches are closed to the test bus position. The test bus ground switch is reclosed, followed by opening the 600-v d-c source switch. This completes all operations in removing the line from service.

Operations for phasing-out test of transmission lines will be presented in an ensuing issue.

Life Of Windings On Power Transformers–IV

A. F. AYRES*
Riverside, Calif.

TEMPERATURE considerations affect transformer windings in exactly the same manner as rotating machines. As an extreme example, one transformer authority has indicated that a transformer winding which should last seventy years at a constant hot-spot temperature of 60 deg C would probably fail in two years with temperature maintained at 100 deg C.

To illustrate the effect of maximum ambient temperatures on transformer life, one power transformer was calculated to have 47 yr life with typical utility loading for maximum monthly ambient temperatures experienced in Pittsburgh. This same transformer authority provided a life curve which could be translated to Pacific Coast locations. Considering yearly aver-

* Fourth and final in a series on life of windings which began in EW June 19, 1947, page 106. Author is ass't electrical engineer, California Electric Power Co.

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Customer good-will becomes more than mere words when service entrances are installed *underground*. Where there is discrimination of ownership, pride in a home beautiful, the home owner will appreciate the avoidance of unsightly overhead wires through installation of RoMarine-RoPrene.

One of the few Underwriters' *approved* types now available, RoMarine-RoPrene can be safely installed for all National Electrical Code approved 600 volt underground entrances, with operating temperatures up to 60° C. RoMarine is a long-aging insulation with excellent electrical stability in wet locations. RoPrene (Neoprene) sheath provides high resistance to soil acids and alkalies, abrasion, as well as sunlight and oxidation. Here, then, is *double* protection in a *single* cable from power circuit to meter . . . economical installation through the use of a single cable and assurance of lasting, trouble-free service.

Available as both single and multiple conductor, RoMarine-RoPrene has found wide acceptance among utilities as the ideal cable for low voltage "net-work" circuits, buried directly in the earth or in ducts, as well as, transformer leads, pole riser cables and other general purpose wiring. For full test data and construction details, write for your copy of Specification RR-1 today.

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Frankel Split Bolt Connectors are easy to use on all types of connections, whether temporary or permanent. A proven favorite for taps, dead ends, motor leads, and in junction boxes, etc. For working in close quarters or mean spots, you can't find a better connector than a Frankel "Bug."

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1. Extra length pressure bar extending beyond nut, keeps threads firmly meshed, prevents stripping.
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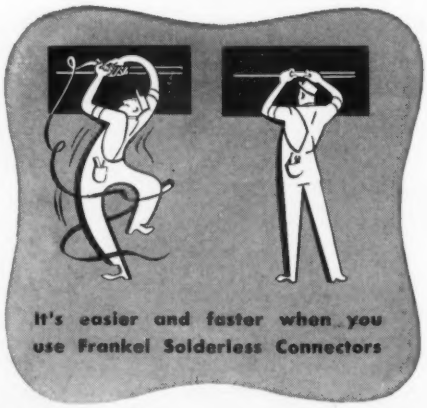

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42 YEARS OF KNOW-HOW IN SOLDERLESS CONNECTORS

age of mean monthly maximum ambient temperatures and identical loading, the anticipated transformer winding insulation life in the California points listed would be as follows: San Francisco, 40 yr; San Diego, 30 yr; Los Angeles, 25 yr; Fresno, 18 yr; Blythe, 8 yr. It seems rather doubtful if actual operating experience justifies these extreme figures.

The California Electric Power Co system has 41 larger power transformer banks in use, 13 of which have been in operation over 30 yr. The oldest bank still in use is 39 yr of age. In spite of this advanced age of many transformers, no wholesale replacement program is anticipated for the immediate future.

Two transformer banks, each 38 yr of age, show a perfect record from the standpoint of windings, and yet, recently, one unit suffered a cooling coil failure. These transformers have operated at the full load point for extended periods but have never been subjected to high ambient temperatures. Another bank, 32 yr of age, has been subjected to full-load conditions at frequent intervals and has withstood the most severe high ambient temperatures offered by either Imperial or Coachella Valley without insulation failure.

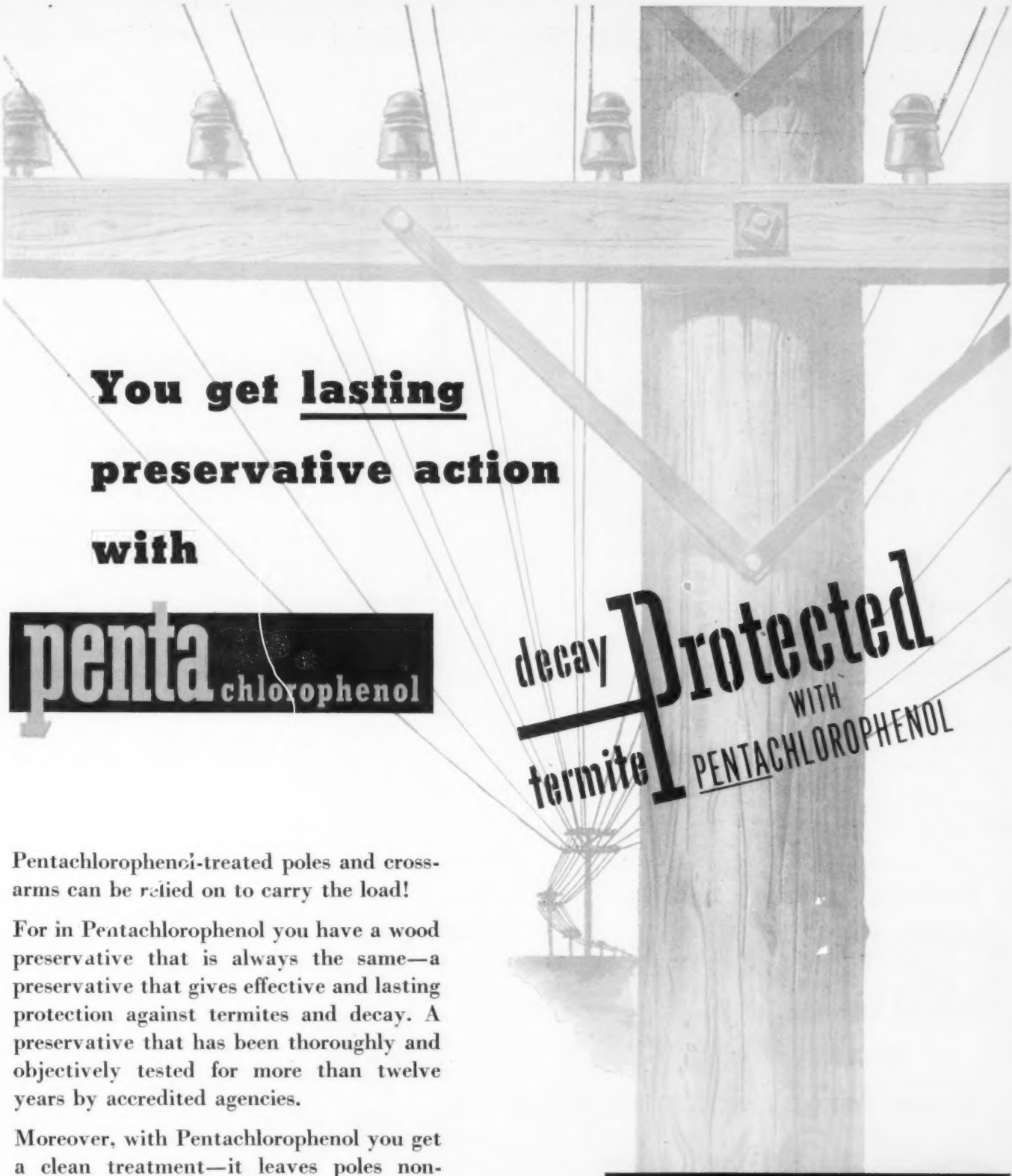
No study has been made in an attempt to isolate transformer winding failure from other troubles such as bushing or terminal board flashovers.

Emergencies Handled Co-Operatively—I*

ALL LEADING power and telephone systems in Connecticut work together on a mutual assistance plan during general emergencies. The breakdown of this plan, which contains many valuable operating suggestions of widespread significance, comprises the substance of the following series of items:

The general purpose is to provide for co-ordinated effort by these utilities in the restoration of their services after an emergency affecting a large number of customers of both. This is to be done in as short a time as can reasonably be expected. The plan is intended to apply to the several power companies separately with such modifications in detailed application as

*Beginning a series of three articles



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Moreover, with Pentachlorophenol you get a clean treatment—it leaves poles non-sticky and easy to handle.

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Industry uses more

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For Armored Construction . . . specify

AMERICAN BLOCKS AND SHEAVES

●A complete line of wire rope blocks—all types, all sizes, in capacities from 1½ to 250 tons. Thick steel side plates, heavy pins and axles. Ask for American equipment when ordering.

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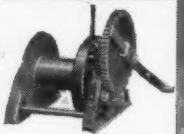


●Gives one man the power of a crew. Weighs only 95 lbs. Handles lifting, loading and pulling jobs up to 5 tons. All steel construction. Ask your distributor.

may be necessary. Each power company's territory and the corresponding telephone company exchanges are defined and indicated on a map prepared jointly by the two companies in question.

In communities where power company district or general headquarters are located, the telephone company establishes a district headquarters on an emergency basis where such headquarters is not normally in operation. Normal organizations of both companies are augmented as appropriate.

Preparatory Measures

Lists of key personnel are interchanged between companies. Details of these lists include the general functions of each person listed, together with office and home telephone numbers.

Each company provides such maps as may be mutually agreed upon as of assistance in the emergency restoration of service covered by the overall plan.

On the approach of an emergency of which advance warning is received, a designated official of each company communicates with the other to insure that both companies are cognizant of the danger and are prepared to set up any necessary mutual arrangements. At this time, if the situation appears sufficiently serious, each company appoints a co-ordinator for liaison functions. Where no advance warning is received, this contact is made as soon as it is recognized that an emergency exists.

Priority Customers

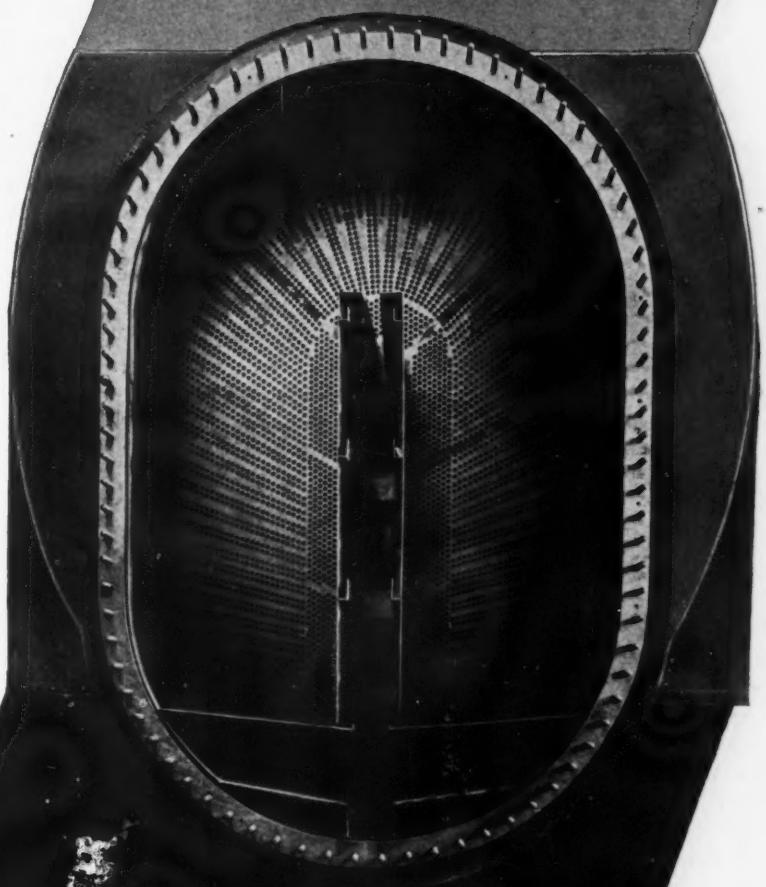
Lists of individual priority customers are interchanged so that each company may know where the other may be expected to require immediate restoration of its service. Where it is felt that such information will be valuable, power company lists include a designation of those customers who are equipped with standby service. Information as to main feeder routes carried on jointly occupied poles is interchanged in preparation for early joint action in restoration work on such plant if disarranged.

The plan provides for review by both companies together at a prescribed time each year. This is done to make such changes as experience may indicate to be essential, and to bring interchanged lists and data up to date.

continuous operation
and performance
over a wide range
of duty..."

Foster Wheeler Condensers Meet Specifications

That is why the Texas Power and Light Company purchased another Foster Wheeler condenser for its Trinidad Station.



No. 4 Unit at Trinidad—28,000 sq. ft.—serving a 40,000 kw turbine

This cross-flow condenser was installed at the Trinidad Station a few years ago. It is a single-pass, non-divided water box unit. Auxiliary equipment includes a twin steam jet air ejector, two condensate pumps, and two circulating pumps.

FOSTER WHEELER CORPORATION
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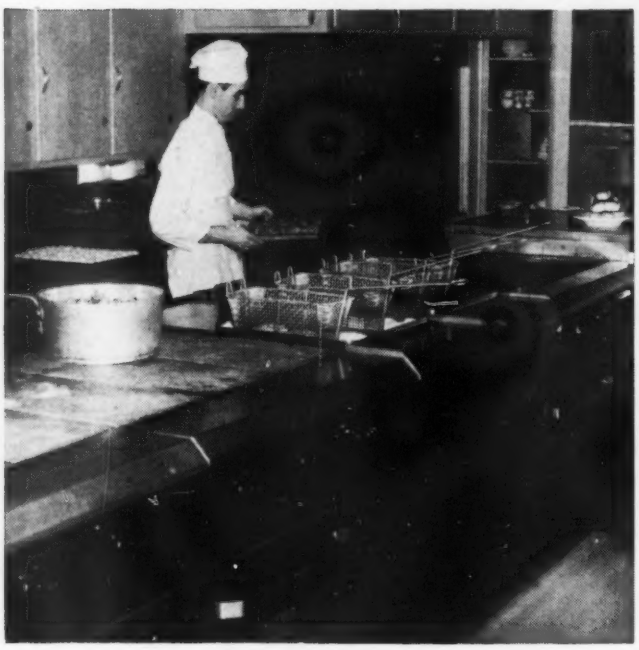
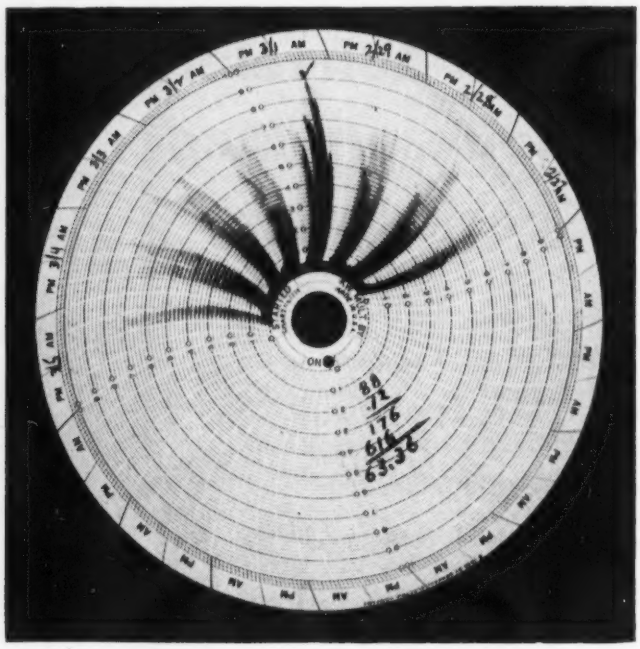
FOSTER WHEELER

LOAD BUILDING



COMPACT INSTALLATION of commercial electric cooking equipment increased dining room space by 30 seats



DEMAND CHART for 8 days shows that maximum peaks occur in forenoon as general rule, and that afternoon loads run below forenoon

Daytime Peaks Make Restaurant Load Desirable

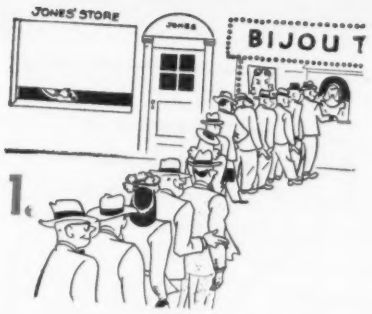
MODERNIZATION of Wilbur's Colonial Kitchen at 41 Charles Street, Boston, included all-electric cooking and other improvements. Previously gas cooking had been used. A new layout by Thompson Wincester, Inc, Boston, in co-operation with the Boston Edison Co, resulted in more dining room space, cutting down walking by employees. The compactness of the electric kitchen set-up allowed the management to convert nearly half the former kitchen area to dining room uses. This gave room for 30 more seats, enabling the establishment to provide breakfast facilities formerly unavailable on a cafeteria basis. Over 200 patrons use this new service each morning, adapted to Beacon Hill requirements.

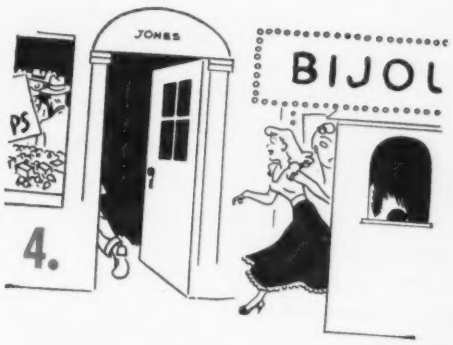
About 600 meals daily are served in the Colonial, open seven days a week. Two dining rooms totaling 3,600 sq ft are available. A representative month's usage of purchased energy totals 20,000 kw hr. Total connected load approximates 125 kw. This includes 10 kw in lighting, 5 kw in motor drives for refrigeration, fans, dish washing and oil burner equipment, and approximately 110 kw in cooking units. In the kitchen are two 22-kw ranges, a 10.5-kw broiler, two 7-kw fryers, a 15-kw griddle range, two 4.2-kw double-deck bake ovens, one 5-kw hot food table, two 2.5-kw (4 slice) toasters, a 6-kw coffee urn and 1-kw roll warmer. Virtually all the equipment in the kitchen is Hotpoint except roll warmer and toaster (McGraw Electric), and a Blickman coffee urn.

In a typical 8-day run the energy consumption was 4940 kw hr and the maximum demand 63.36 kw. Energy used was a little over 1 kw hr per meal. Load-factor on the basis of 24-hr operation per day was about 40%.

The management expresses itself as highly pleased with electric service, as are its employees. Ovens and ranges are cool to operate. The speed of the deep fat fryer is superior. Vincent Wilbur, proprietor, states that in all the years he has operated the kitchen, it has never prepared better food or had as good service. "Electric cooking equipment puts us on the map," he said.

Most of the business of this restaurant, located in a business district, is done at the noon meal. Except for baking and roasting, practically all of the lunch-time cooking is done then also. This, with the requirements of food service equipment, makes the electrical demand come in a valley period of the daily load curve. Fewer meals being served at dinner time, the afternoon peak of this load is much lower than in the morning. This off-peak characteristic is a consideration in the development of commercial cooking load.





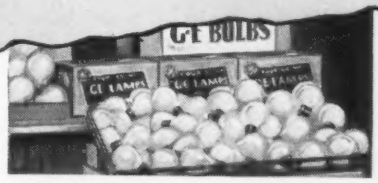
G-E LAMPS SELL ON SIGHT!

...especially in the new G-E 4-LAMP PACKAGE

RECENT sales tests show that retailers' lamp ... advertising have b...

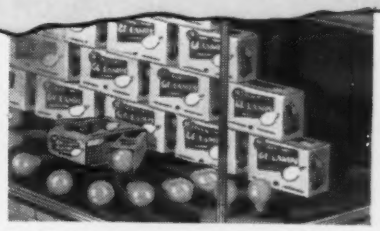
PROMOTING the new G-E 4-Lamp Package through G-E lamp dealers is one way General Electric is helping fill empty sockets in homes everywhere.

This advertisement runs during July in Electrical Wholesaling, Hardware Age, Hardware Retailer, Lighting and Lamps, and Retailing Home Furnishings.



STACK 'EM UP AT YOUR CASH REGISTER. The colorful G-E 4-Lamp Package will get you many an extra sale when displayed in this hot sales spot.

SPREAD 'EM OUT ON YOUR TABLES. Nestle some 4-Lamp Packages around a bin of bare bulbs, and watch your average sale per customer climb.



HEAP 'EM UP IN YOUR WINDOWS. They'll remind passers-by that they need light bulbs and increase traffic into your store.

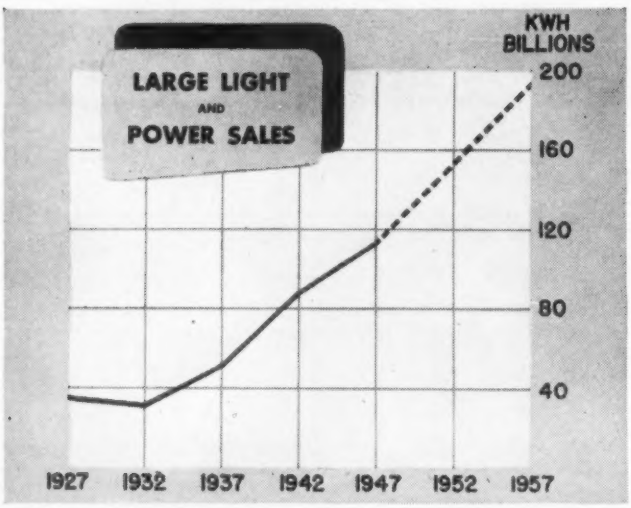
G-E LAMPS

GENERAL ELECTRIC

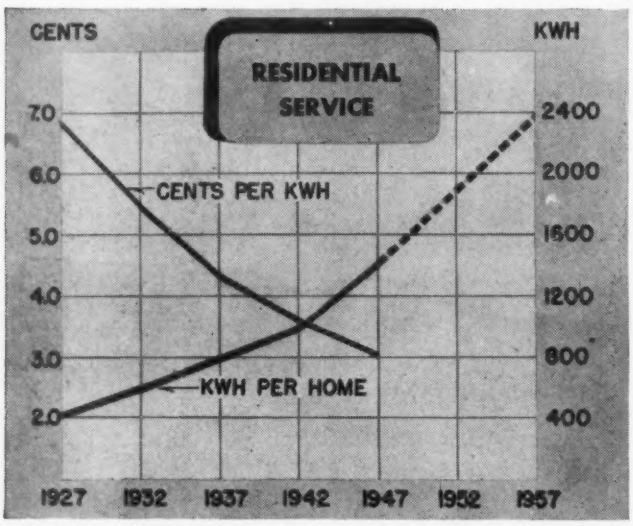
Looking Into The Crystal Ball

FORECASTING the use of electric power for the next ten years, these curves provide a reasonable gage of future utility activity. Taken from a talk by Tom Fort of the Westinghouse Electric Corp before a recent meeting of the Arkansas Utility Association, the curves were originally developed by the combined economic, sales, engineering and market development staffs of Westinghouse in conjunction with many of the country's leading utility companies, banks, industries, and various agencies of the government.

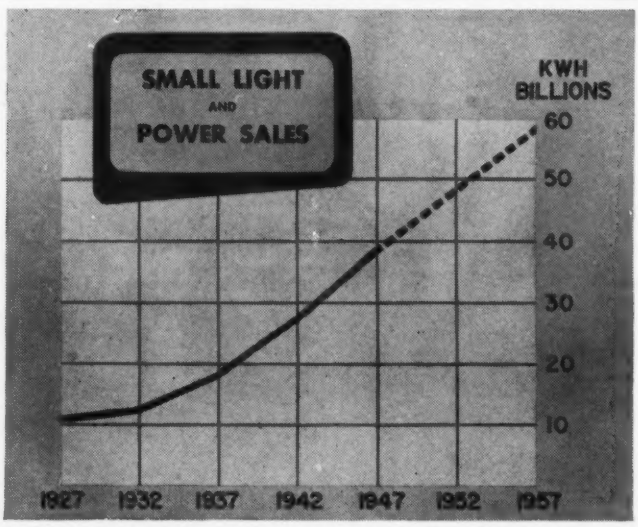
Depicted are the estimated growths for residential, business and industry loads, as well as an indication of the generating facilities that will be needed if these tremendous expansions actually occur.



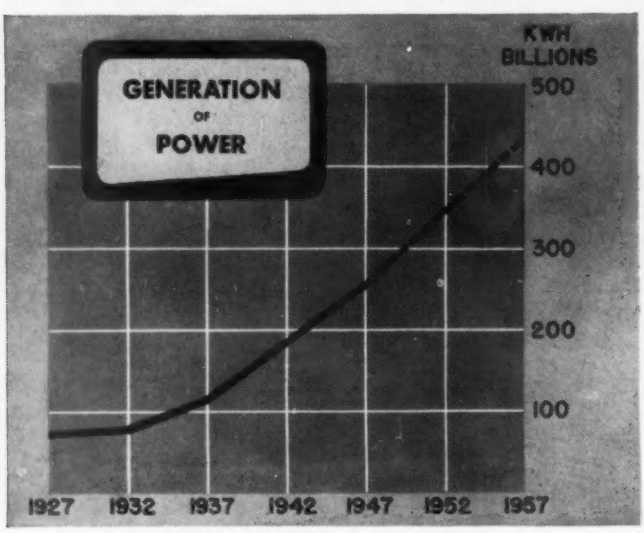
HEAVY INDUSTRY will use a greatly increased amount of electric power. This use of energy will increase from 114 billion kwh per year to 194 billion kwhr



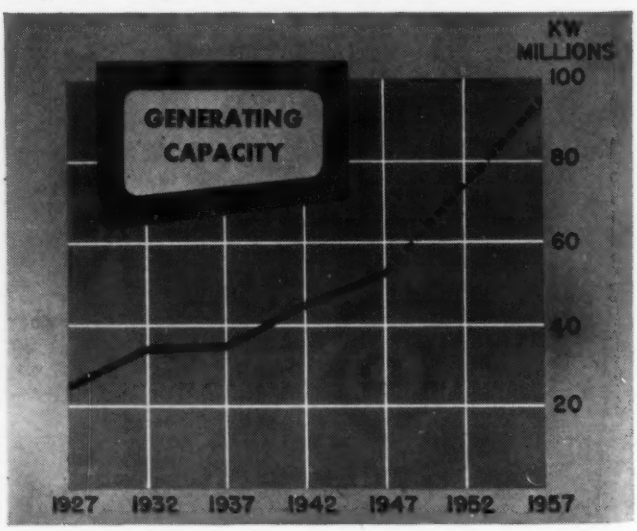
AVERAGE RESIDENTIAL LOAD at the end of last year was 1,438 kwhr per year. By 1957 it is estimated that the average residential use of power will be 2,400 kwhr per year



SMALL BUSINESS and small industries will continue to increase their use of electric power. It is expected that this part of energy sales will go from 38 to 58 billion kwhr



IN 1957, approximately 430 billion kwhr will have to be generated compared with 256 billion last year, allowing 15% for system losses



GENERATING FACILITIES will have to be expanded by more than 80% to carry these greatly increased loads during the next decade

made to sell with **chromel***

*the *original* nickel-chromium heating element wire

Durable CHROMEL resistor wire . . . basic element of electrical heating. The wire that's used in countless appliances and furnaces . . . the wire that represents an important factor in building and maintaining your domestic and industrial heating loads. Our Catalog-M1 tells the complete technical story . . . want a reference copy?

HOSKINS MANUFACTURING COMPANY

4445 LAWTON AVE. • DETROIT 8, MICHIGAN

NEW EQUIPMENT

Insulating Machine

AN AUTOMATIC armature slot insulating machine has been developed by Globe Tool & Engineering Co, 436 Davis Av, Dayton 3, Ohio. The inserting machine automatically indexes the armature, inserting insulators at a rate of approximately 2 slots per second, and automatically stopping when the final slot is insulated.

On a production basis, a typical 11-slot armature has been insulated under suitable incentive, resulting in a sustained rate of 450 armatures insulated per hour.

•

Network Transformers

A NEW LINE of silicone-glass insulated, dry-type network transformers is announced by Westinghouse Electric Corp, P.O. Box 868, Pittsburgh 30, Pa. Constructed entirely with inorganic insulation, bonded with materials like silicone and containing no inflammable oils, fire and explosion hazards are reported eliminated. Fire-proof vaults are not required, it is claimed. The transformers are sealed hermetically by welding and can operate when submerged by flooding.

The transformers are filled with dry nitrogen permanently sealed in place. Cases are constructed of copper-bearing steel to resist corrosion. A special under coating on the bottom of the transformer is said to give extra protection.

Units are available in both 5-kv and 15-kv classes in sizes of 150, 225, 300, 500, 600, 750, and 1000 kva, 3-phase. High-voltage switches and low-voltage network protectors can be supplied either mounted on the transformer or for separate mounting.

Loom Motor

A NEW totally enclosed Tri-Clad loom motor specially designed to meet the particular requirements of loom operation has been announced by the Small and Medium Motor Divisions of the General Electric Co. Although covering the entire range of 2 hp, 1800 rpm and smaller, all ratings are built in a single frame diameter with but two axial lengths. This permits changing horsepower or speed ratings on a particular loom to suit mill requirements with minimum loom modification.

All ratings are available for foot mounting or for 3-arm suspension. Other features include: more conveniently located oil fittings, a new design wool-packed, steel-backed bronze sleeve bearing, and an oil-resistant multiconductor jacketed cable to withstand the heavy vibration met in loom applications.

•

Reflectoscope

PRODUCTION of a new supersonic reflectoscope, type SRO-5, has been announced by Sperry Products, Inc., 1505 Willow Ave., Hoboken, N. J. It is designed for non-destructive testing of metals and other materials for internal defects, and for testing welds. Specifications of the new instrument are reported to match those of the model presently in wide usage, but radical changes have been made in size, appearance and operation.

The new unit is approximately 14 in. x 16 in. x 23 in., and is carried by means of handles on the case. Over-all weight is approximately 85 lb.

Sensitivity is stated to remain the same, but operation has been simplified by reducing the number of external controls to five. With these controls the operator varies sensitivity, pulse width, sweep length, screen markers, and frequency. Visual indication of internal defects remains unchanged on the oscilloscope screen, but the tube is a smaller, 5-in., high-intensity type.

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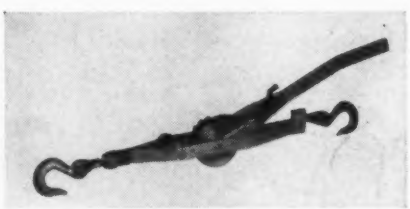


One-Man Hoist

A ¾-TON capacity hoist weighing 6 lb has been designed to facilitate certain lifting and pulling jobs by one man. Known as Pow'r Pull, the hoist has been introduced by American Cage and Mfg Co, 125 Bayard St, Dayton 1, Ohio.

The hoist can be used on horizontal or vertical pulls, has a cable reel with ratchet and lever, is equipped with hooks at end of frame and on cable, is furnished with various lengths of cable, and tested to 50% overload.

•

Diesel Electric Plants

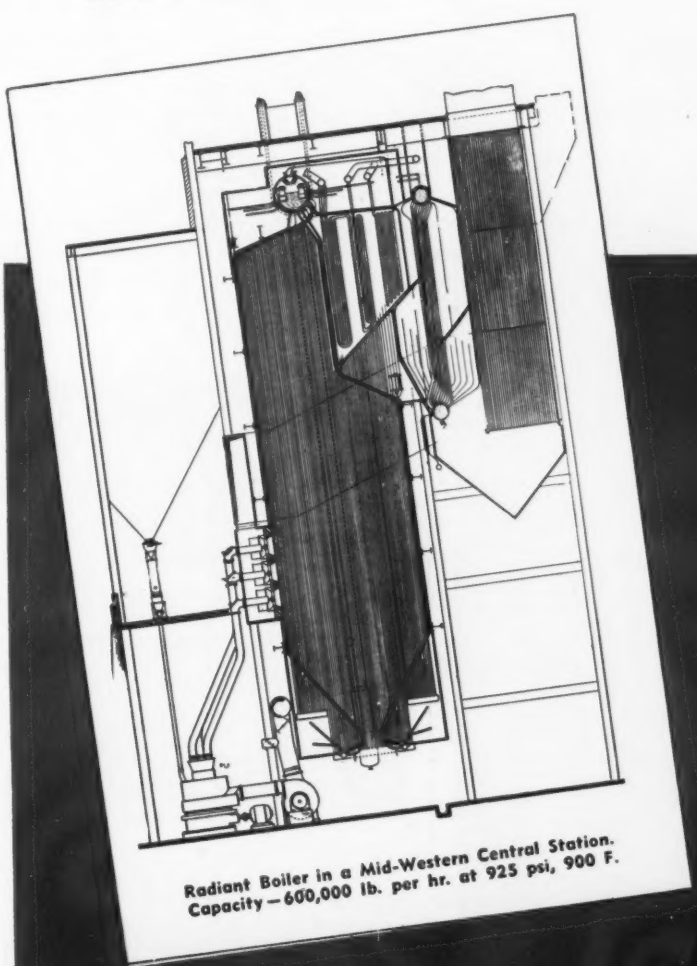
AN AIR-COOLED diesel engine is the prime mover for a 2500-w electric plant developed by D. W. Onan and Sons Inc, 43 Royalston North, Minneapolis, Minn. Compactness (10½ cu ft) of the unit makes it adaptable to portable or stationary jobs. The one-cylinder, four-cycle engine requires approximately 0.136 gal of fuel per kwhr at full rated load.

The model 205DSP plant has electric cranking and the engine and generator

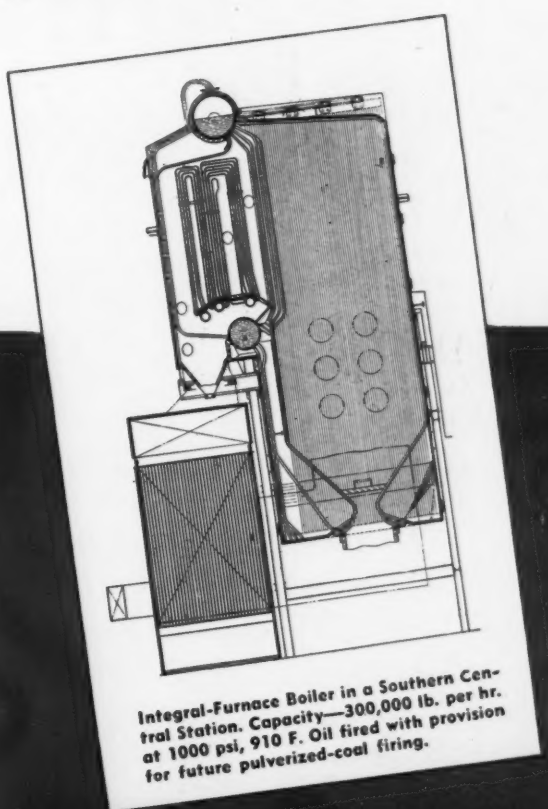
MATCHED TO MODERN NEEDS

In modern Open-Pass, Radiant, Stirling, and Integral-Furnace Boilers, B&W is providing the central-station industry with time-tested, performance-proved designs for low-cost steam generation over the entire range of present-day requirements. Long, satisfactory experience with these types reflects their high standards of performance as to continuity of service, dependability, overall operating efficiency, adaptability to all types of fuels, and greatest return on investment.

B&W experience in matching boilers to jobs for utmost efficiency and economy covers three times twenty-five years and more. Such experience cannot be written into specifications or shown on blueprints but it is a part of all modern B&W boilers that is contributing to low-cost power production.



Radiant Boiler in a Mid-Western Central Station. Capacity—600,000 lb. per hr. at 925 psi, 900 F.



Integral-Furnace Boiler in a Southern Central Station. Capacity—300,000 lb. per hr. at 1000 psi, 910 F. Oil fired with provision for future pulverized-coal firing.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.

MOSINEE PAPER MILLS CO. MOSINEE, WISCONSIN REG. U.S. PAT. OFF.

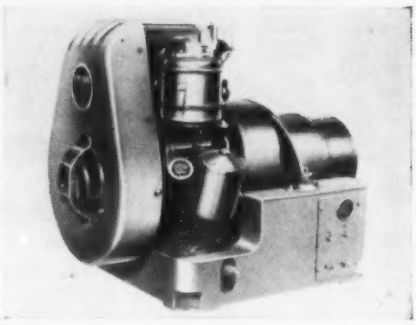
MOSINEE

"More than Paper"

In the field of electronics and the electrical goods industry, MOSINEE stands for paper-base processing materials with scientifically controlled chemical and physical properties, high quality standards and dependable uniformity... with good dielectric strength, high tensile or tear strength; proper softness or stiffness; creped with controlled stretch or flexibility; specified pH for maximum-minimum acidity or alkalinity; accurate caliper, density, liquid repellency or absorbency . . . or other technical characteristics vital to your quality standards and production requirements.

MOSINEE PAPER MILLS COMPANY • MOSINEE, WIS.

"Essential Paper Manufacturers"



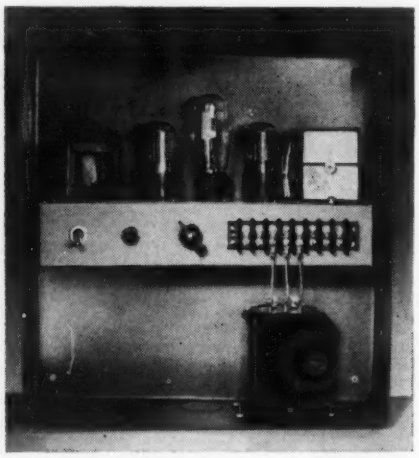
controls are located on the steel base. Generator 60-cycle capacities are available for 115 and 230 v, single and 3-phase. Accessories include two 6-v starting batteries, oil filter, muffler, two flexible fuel lines, hand crank, fuel injection pump, remote start and stop station.

•

Insulation Tester

RECENT DEVELOPMENT by Herman H. Sticht Co, 27 Park Place, New York 7, N. Y., is Model B-6 Megohmer which combines four instruments in one as follows: (1) Insulation tester—0-200 megohms with 500v d-c test potential; (2) Ohmmeter—scale 0-2000 or 0-20,000 or 0-200,000 ohms; (3) A-C voltmeter with two ranges, 0-150 and 0-600v; (4) D-C voltmeter with two ranges, 0-150 and 0-300 v.

Power is furnished by two No. 6 dry cell batteries and is stepped up to 500v d-c by vibrator-transformer circuit. Triple color grading scale is included to indicate insulation as good, fair or doubtful.



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Overcurrent Relay

MODEL 1079 is an electronically operated relay designed to provide overload protection or to operate a recorder. It is a product of Electronic Controls, Inc, 44 Summer Ave, Newark 4, N. J.

The unit consists of the relay and a 0-5 amp current transformer mounted in a 12x12x4-in. steel knockout box. One

CHANCE GK-5 Switches*

7.5 to 287 KV

Long Life, High Pressure Area Contacts wipe clean without abrasion

CHANCE GK-5 Switches are fulfilling many big assignments on voltages up to and including 287 KV. They are performing with precision under widely varied climatic conditions. Designed by engineers who are experts on power switching operations—men who have many "firsts" to their credit for solving major switching problems—these switches are now available from coast to coast.

All details of the control mechanism of GK-5 switches have been designed to give years of smooth, dependable performance without field maintenance. Oilite bearings are used throughout . . . Switches for 69 KV and above have switch blade counter-balancing mechanism for easy gang operation . . . High pressure contacts are obtained by a simple toggle device.

● **LARGE AREA CONTACTS** give low contact resistance, maximum conduction of heat away from contacts during short circuits.

● **SILVER CONTACT SURFACES** — lower contact resistance by preventing copper oxidation.

● **GENTLE WIPING CLEANS CONTACTS.** The blade and clip contacts engage under moderate pressure during the blade movement. This wiping action cleans silver surfaces *without abrasion.*

● **HIGH PRESSURE AFTER CLOSING.** High pressure is applied after switch blade has completely closed. Pressure is released before blade travel starts, minimum contact resistance is obtained without surface abrasion, insuring long contact life.

Diagram and cutaway photo show the contact mechanism of the GK-5. After closing motion is completed, control rod, actuated by a cam, causes toggle links to press against leaf springs which set the high pressure between contact surfaces.

C486

* CHANCE SWITCHES (FORMERLY BOWIE) ARE BACKED BY 42 YEARS OF SWITCH ENGINEERING AND MANUFACTURING EXPERIENCE.

A·B·CHANCE CO·

210 N. ALLEN STREET CENTRALIA, MISSOURI · 815 TENNESSEE STREET SAN FRANCISCO 7, CALIFORNIA

ABC INDUSTRIES

71-1-1

BEHIND THE IRON CURTAIN

what goes on—beyond this barrier?

Not always what theory teaches us. More than modern instrumentation can tell us. Much, indeed, that only off-the-line inspection will reveal — too late, perhaps, for corrective action.

Yet here-and-now facts on the condition of internal boiler surfaces are always yours when APEXIOR NUMBER 1 guards tube and drum steel.

For APEXIOR permanently stabilizes metal beneath a surface which moisture cannot penetrate. Thus isolated from any environment with which it can react to its own detriment, APEXIORized steel loses none of the characteristics of new or newly cleaned metal — can be depended upon for changeless year-in, year-out service.

A further benefit is that APEXIOR's smooth surface attracts fewer and less tenacious deposits so that tubes and drums stay cleaner longer for uniform heat distribution, better circulation and constant high heat transfer efficiency.

These are some of the reasons why for 31 years APEXIOR has played so important a role in the power plants of American industry — why today engineers in ever-increasing numbers specify it for boilers of all pressures and ratings, operating under all conditions of feedwater control.

For a complete picture of what APEXIOR protective surfacing can mean to your boiler, write us for more facts about

DAMPNEY Maintenance for Metal

THE DAMPNEY COMPANY of AMERICA • Hyde Park, Boston 36, Mass.

wire running to a motor, transformer or other device is connected through the current transformer primary. The secondary is connected to the electronic relay which may be adjusted to operate on a current change of 10%. Output relay spdt contacts are rated 10 amp, 110-v and 5 amp, 220-v, 50-60 cycles.

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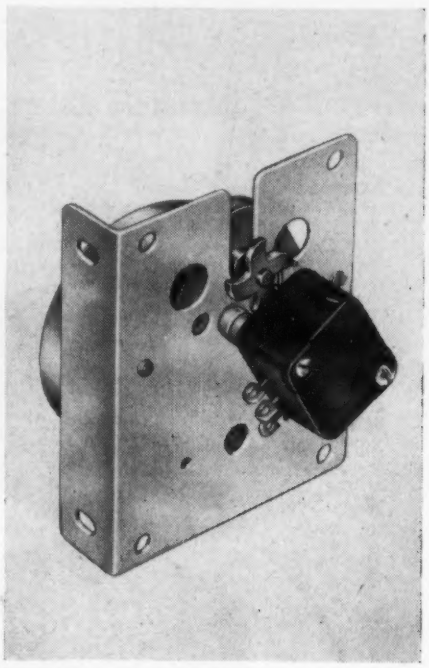


Flasher Timer

FOR APPLICATIONS that require current fed to a controlled circuit in pulses, a new series of interrupter or flasher timers has been designed by the Haydon Mfg Co, Inc, Torrington, Conn.

The 5400 series timer has as the basic unit a timing motor, assembled with a 4-lobe cam, steel wire cam follower and small Micro-switch rated 5 amp, 125 v a-c.

Range of the timer is from 72 pulses or flashes per min, each 4/10 sec in length, to 1 pulse every 2 min, each 1 min in duration. Typical intermediate flash rates are 60, 50, 30, 20, 10, 5, 3, 2 and 1 pulse per min.

•

Portable Tool Box

AN ALL-STEEL, welded tool box, known as the HanDeeBox, is being manufactured by Littleford Bros, Inc, Cincinnati, Ohio. It is furnished with pneumatic tires, semi-elliptical springs, steel axle and roller bearing wheels;

1,500 KVA Transformer—60 cycle 3 phase, 14,400 to 2,300 volts, with radiators arranged for air blast cooling for future increased capacity.

NIAGARA TRANSFORMERS

Tested

to NEMA and AIEE Standards!

Every Niagara Transformer undergoes a rigid test before it leaves our plant! We're of the size where we're able to make tests—and *do!*

In meeting NEMA and AIEE Standards there is a Niagara standard also; *reliable performance.* It is achieved through liberal design, use of highest quality materials throughout, painstaking workmanship, and expert supervision.

Niagara Transformers are manufactured up to and including 33,000 Volts Primary.

Deliveries are good on Oil Type, single and three phase. Contact us at once for full details.

ERIE ELECTRIC CO., INC.
CHURCH & BIRDSALL STREETS, BUFFALO, NEW YORK

ERIE ELECTRIC CO., INC.
CHURCH & BIRDSALL STS., BUFFALO, N. Y.

We are in the market for

.....AMT .....KVA .....CYCLE .....PHASE
.....PRI VOLTS .....SEC. VOLTS

Name.....
Address.....
City.....State.....

CRESCENT
IMPERVEX TRENCHWIRE

For Lower Cost Underground Use

● CRESCENT IMPERVEX TRENCHWIRE provides the LOWEST COST, PERMANENT underground installation for services from power line to meter, for connecting several buildings from the same service, as on FARMS, ESTATES and INSTITUTIONS and for STREET, AIRPORT, BALL PARK, DRIVE-IN THEATRES and other outdoor lighting and power circuits.

● CONSTRUCTION. The single copper conductor is insulated with IMPERVEX special moisture and heat-resisting rubber insulation. A tough NEOPRENE armor sheath is vulcanized over the insulation, protecting it from injury during and after installation. The cable is flame-retarding and practically UNAFFECTED by water, oil, acid, alkali, sunlight and exposure to the earth or weather;—nothing to rot, rust or corrode.

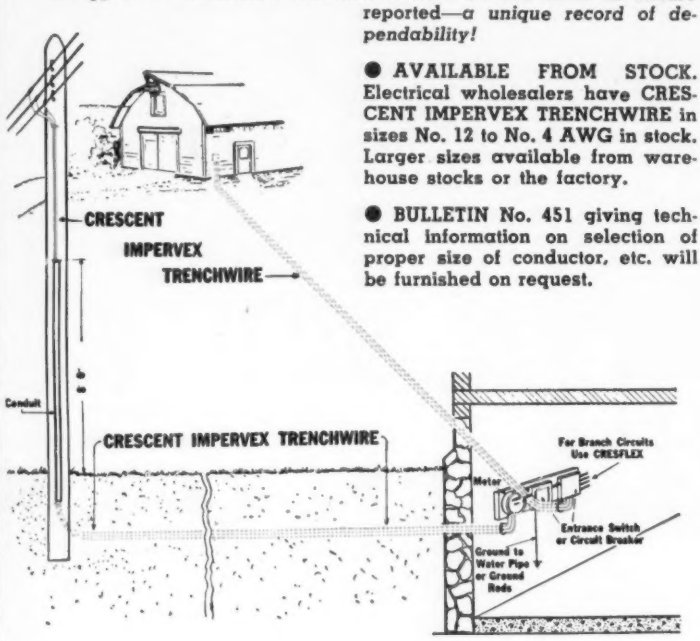
● EASY INSTALLATION. Two or more IMPERVEX TRENCHWIRES are laid together in a narrow trench to form the cable with no additional protection normally required.

● APPROVED. Carries Underwriters' Laboratories' Labels as TYPE USE—Underground Service Entrance Cable, and conforms to the National Electrical Code.

● PROVEN. Tens of millions of feet of CRESCENT IMPERVEX TRENCHWIRE have been installed over the last seven years under all types of installation conditions, with not one case of failure reported—*a unique record of dependability!*

● AVAILABLE FROM STOCK. Electrical wholesalers have CRESCENT IMPERVEX TRENCHWIRE in sizes No. 12 to No. 4 AWG in stock. Larger sizes available from warehouse stocks or the factory.

● BULLETIN No. 451 giving technical information on selection of proper size of conductor, etc. will be furnished on request.



CRESCENT
WIRE and CABLE

CRESCENT INSULATED WIRE & CABLE CO.
TRENTON, N. J.

said to make it easy to trail the portable box at high speed.

The box is reported to be fireproof, weatherproof and thiefproof. Safety catch holds covers in open position. Locking chains keep box from being trailed, when left on the job. Adjustable legs keep box steady. Caster wheel folds under box when trailing.

Sliding shelves are divided into compartments for housing first aid kits, records, files, small tools, fittings, etc. Brackets and lugs are provided for storing tools.

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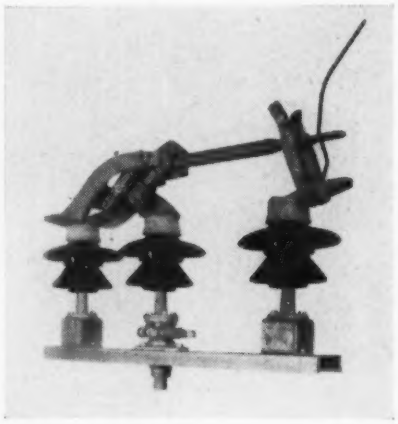

Air Switch

A NEW VERTICAL break air switch has been announced by the Delta-Star Electric Co, 2400 Fulton St, Chicago 12, Ill. Known as the "MK-40", this line of switches is available in all standard voltage and ampere ratings, for upright, inverted or vertical mounting.

This switch is the rotating blade, high pressure contact type and is said to incorporate numerous new features. Claimed for it are electrical and thermal characteristics emphasized by a minimum of current interchange surfaces, and simplified, positive mechanical design embodying a minimum number of parts.

•

General Purpose Varnish

A NEW INSULATING varnish announced by General Electric Co, Schenectady, N. Y. is stated to possess the best combination of electrical, mechanical and chemical properties ever attained in a G-E general purpose varnish. The new material, designated as general purpose varnish No. 9574, can be used with practically all types of winding including enamel, cotton, asbestos, and glass-covered wire.

A thermosetting, phenolic drying-oil varnish, G-E 9574 is said to cure to a tough, pliable mass even in the deepest coils, to give exceptional resistance to oil, acid, alkali, salt water, moisture, and heat, and to be suitable for infra-

IF YOU USE CARBON BRUSHES—

GET IT!

FREE!

Get your free copy of this attractive 24-page booklet, ***"Standardization of Carbon, Graphite and Metal-Graphite Brushes for Motors and Generators."*** Better yet, let us present it in person. Write to National Carbon Co., Inc., Dept. EW.

★

TELLS YOU HOW:

TO BUY IN MORE ECONOMICAL QUANTITIES

The booklet shows how large and small users have saved hundreds of dollars by eliminating many custom-built brushes and standardizing on a few types and grades that can be bought in quantity . . . and do the job just as well.

TO SAVE MONEY ON BOOKKEEPING, BILLING, AND ACCOUNTING

The booklet explains how standardization results in fewer orders to place, with savings all down the line — in stock records, ordering, and payments. Ordering is even further simplified through National Carbon Company's unique system of *"RC Numbers"* — code numbers that cover complete specifications on a given brush without laborious detail.

TO CUT INVENTORY AND STORAGE SPACE

The booklet points out that brush standardization means greatly reduced brush stock — which means less handling time and cost, less money tied up in inventory, fewer requisitions to prepare.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York 17, N. Y.

Division Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

It takes QUALITY PERFORMANCE to get an ENCORE . . .

and YORK-HOOVER BODIES get "encore orders" time after time

The fact that operators everywhere keep re-ordering York-Hoover Bodies is proof of their confidence in and approval of the York-Hoover product.

Specific purpose design to do a particular job, experienced and skilled engineering for dependability, and honest workmanship for economical maintenance and low depreciation—all contribute to this customer confidence and approval.

To meet this healthy, steadily growing demand, York-Hoover has increased plant and production facilities so that we hope to say "prompt deliveries" in the not-too-distant future.

YORK-HOOVER BODY DIVISION CORPORATION

YORK, PENNSYLVANIA

red baking. Possessing excellent aging properties, G-E 9574 is claimed to have good build and flexibility, and to impact excellent dielectric strength.

According to the manufacturer the new varnish is easy to work and can be cured in conventional equipment at baking cycles as low as 212 F. It has a flash point of 100 F and its viscosity at 45 F is 600 C.P. average. G.E. reported that the new insulation varnish can be used at barrel gravity or can be thinned up to 20% with petroleum spirits or any other available commercial thinner.

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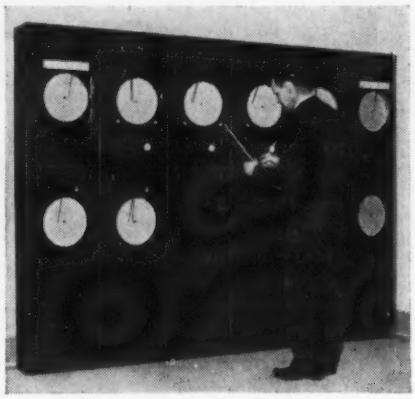


Panel Boards

STANDARD-SIZE, sectional panel boards constructed of 10-gage steel have been announced by K & H Industrial Products, Dept. 7, Akron 11, Ohio, Fabricated to contain any type of control or indicating instrument, sections can be added, interchanged, removed, or otherwise modified to meet changing plant operating conditions.

Standard 18, 20 and 24-in. wide sections are supplied in 6, 6½, 7, 7½ and 8-ft. heights. Each panel has a 2-in. minimum return flange on top, bottom and each side. Floor and wall braces are furnished. Panels have lacquered, hand-rubbed and buffed finish supplied in any specified color.

•

Foot Switch

TO EXTEND the line of machine tool control accessories, a heavy-duty oil-tight foot switch has been developed. It is produced by Square D Co, Industrial Controller Div, 4041 North Rich-

I DO TWO JOBS

BETTER THAN ANYONE ELSE

"I am De Laval Centrifugal Force. I purify lubricating oil, and because I can do two jobs at once I offer more complete protection for plant operating men.

"The two jobs I do? Well, I

1 — Remove dirt and sludge

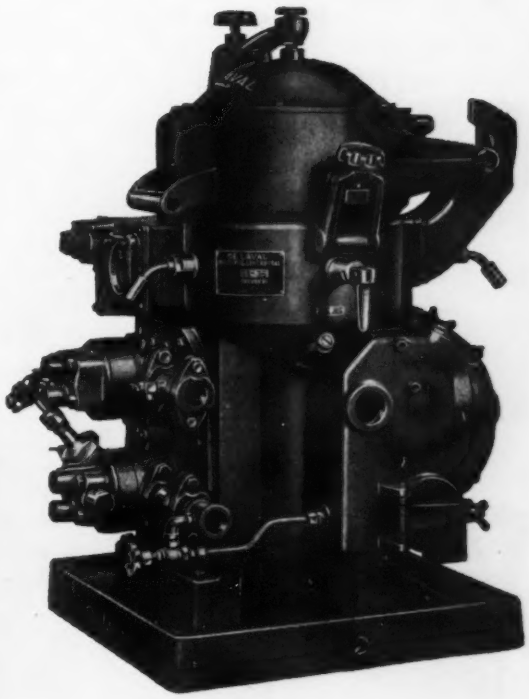
2 — Remove water continuously

"I never do an incomplete job of maintaining oil (for in purifying oil, dirt removal is only ***part*** of the job). As often as not, water is the real trouble-maker. Condensate in turbine oil, for example, leads directly to the formation of sludge. Whatever the impurity in the oil, I promptly remove it.

"I am also a good Oil Purifier because I do not remove oil-soluble additives. Oil is discharged with such additives intact.

• "Read about me in Bulletin 400."

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.



DE LAVAL

Lubricating Oil Purifiers

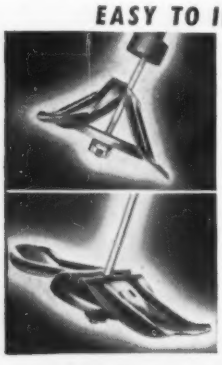
P-L* EARTH ANCHORS

*REA APPROVED

P-L ALL STEEL, EXPANDING TYPE EARTH ANCHORS

Here is the first really efficient, two-piece earth anchor that is of simple, fool-proof, all-steel, heavy-duty construction. P-L Earth Anchors are exceptionally rugged and possess tremendous holding power. P-L Anchors can do a better job and can be installed quicker in all types of soil. Everyone from the engineer to the lineman can appreciate the ease of handling and installation.

EASY TO INSTALL



P-L Anchors come to you as assembled units. Built of two simple pieces of heavy steel plate. A few blows of the tamping bar and the sharp edged blades cut deeply and permanently into solid, undisturbed earth.

FOR LITERATURE WRITE

PIEPER-LILLARD INCORPORATED
ST. LOUIS 1, MO.

ards St, Milwaukee 12, Wis.

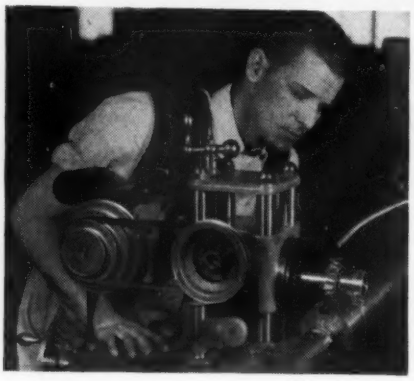
Enclosure is a cast case and gasketed. Wide pedal has guard for protection against accidental contact or falling objects. The switch has adjustable stroke. Short motion and slight angle eliminate ankle fatigue.

Contacts have snap action, are rated 600 v, a c or d c, pilot duty, and have spdt and dpdt arrangements.

•

Portable Tool Unit

KNOWN AS THE VERSA-MIL, a powered tool attachment can serve as a portable machine tool on maintenance and new jobs. It is a product of the Versa-Mill Co., 30 Church St., New York 7, N. Y. By its design, keyways



and faces can be milled, holes drilled and bored, and shafts and flat surfaces ground without the necessity of disassembly and moving the work into a machine shop. Longitudinal and cross feeds are incorporated in the auxiliary base.

The basic or power unit is equipped with either a ½ or ¾ hp motor and has spindle speeds 33 to 295 rpm. A ¾ x ⅜-in. slot in steel can be milled, it is reported, at a rate exceeding 1 in. per min. Using a grinder head, speeds range from 4140 to 13,800 rpm with capacities from 6 in. down to 1 in. diameter wheels.

•

MORE NEW PRODUCTS about which you should know

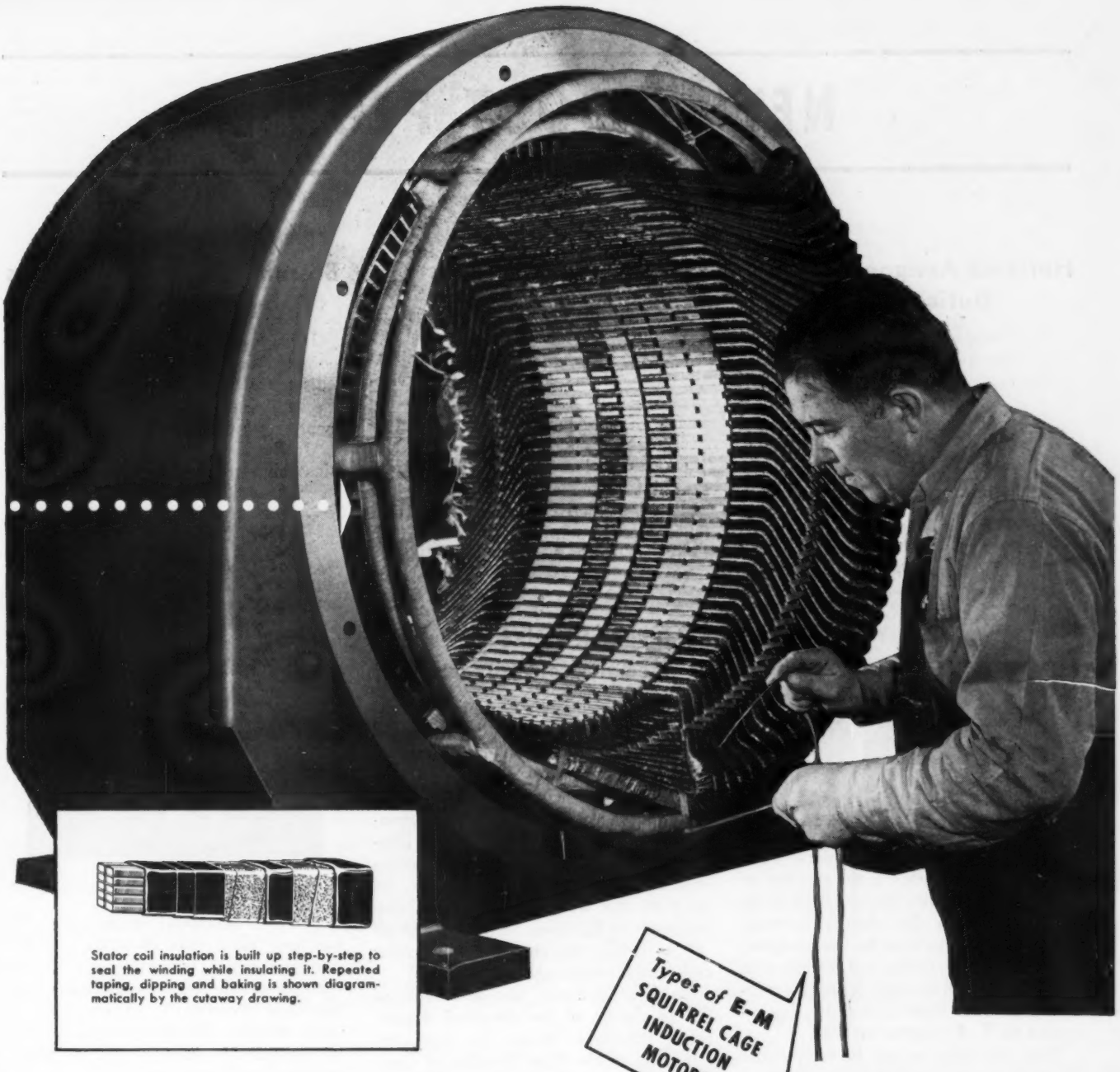
GAR WOOD Industries, Inc, Wayne, Mich., is producing a Reel-Rite **truck winch** with a capacity of 20,000 lb and automatic spooling and tensioning device to avoid loose and crossed coils of cable. . . . Jet Thermal Device Co, 2873-86th St. Brooklyn 14, N. Y. has a "Slim Jim" **soldering iron** shaped like a pen, weighs 3½ oz, has removable tips and replaceable thermal cartridges for 35 and higher. . . . Bin-Dicator Co, Dept. J-906, 14615 East Jefferson Av, Detroit 15, Mich, is producing the Bantam Bin-Dicator (5¾ in. overall diam) a diaphragm-operated **switch** in sealed housing which mounts on outside of bins, hoppers and conveyors and signals changes in material levels.

Potter Instrument Co Inc, 136-56 Roosevelt Av, Flushing, N. Y., has multiple sequence predetermined **electronic counters** designed for counting speeds up to 15,000 per min and at higher rates. . . . Metron Instrument Co, 432 Lincoln St, Denver 9, Colo, offers a type 48U **speed indicator** (100-5000 rpm scales) to test gasoline motors; terminals are clipped to car battery and distributor breaker points. . . . Square D Co's Kollsman Instrument Div, 80-08 45th Av, Elmhurst, N. Y. developed two drag cup **motors;** one for 3000 rpm, 115 v, 60 cycles and other for 5000 rpm, 115 v, 400 cycles, with maximum stall torques of 0.32 to 0.41 oz-in.

Thomas & Betts Co, Elizabeth 1, N. J., developed a solderless **wire joint** consisting of insulation molded around a seamless bronze barrel; known as Sta-Kon, Cat. RB-4, for appliances and fixture manufacturers. . . . Weller Mfg Co, Easton, Pa, announce two models of **soldering guns;** ES-110 and ES-220 provide single heat at 100 w with a 4-in. reach from housing to tip, for use on 110 or 220 v at 50 or 60 cycles, principally intended for export. . . . General Scientific Instrument Co, P. O. Box 6798, Philadelphia 32, Pa., produces an Eye Sweep, an **eye instrument** with a magnet to remove metals and a loop to remove cinders and dust.

Bach Electric Corp, Bridgeport, Conn, announces fractional horsepower **motors** in sizes 1/500 to 1/50 hp, 110 v, 50-60 cycles and shaded-pole squirrel-cage type, with fibre-glass insulation and welded construction. . . . Ripley Co, Inc, Middletown, Conn, developed a **burglar alarm** using a modulated invisible light beam; any change in frequency or reduction of light intensity will cause the alarm to sound. . . . Eutectic Welding Alloys Corp, 40 Worth St, New York 13, N. Y., manufactures an "Anti-Capillary Compound", a **paste compound** designed to confine the flow of molten alloys to the limited area upon which the weld is to be applied; for use with Eutectic Low Temperature Welding Rods.

G. H. Leland Inc, 155 Webster St, Dayton 2, Ohio, has developed two Ledex rotary **solenoids** said to produce 25 and 50 lb-in. respectively, with a rotary stroke of 45 deg. . . . Modern Utilities Co, 3733 LaSalle St, St. Louis 10, Mo, manufactures an **air circulator** with a 3-blade 12-in. impeller driven by 1/30-hp motor.



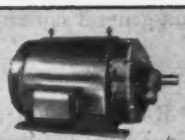
Stator coil insulation is built up step-by-step to seal the winding while insulating it. Repeated taping, dipping and baking is shown diagrammatically by the cutaway drawing.

Types of E-M SQUIRREL CAGE INDUCTION MOTORS

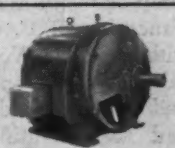
LET US TELL YOU MORE ABOUT "BIG MOTOR" ENGINEERING

● Yes—there's a big difference in Big Motor Engineering. You see it in the indestructible rotor construction, the cool-running, wear-resistant bearings and the motor protection of E-M Heavy Duty Induction Motors, as well as their long life insulation. They are differences that mean faithful, profitable performance—that make these heavy-duty induction motors exceptional values. Write for full data in our publications 189, 190.

Two-pole; drip-proof; ring lubricated bearings.



Two-pole; drip-proof; pressure-lubricated bearings.



Four or more poles; drip-proof; sleeve bearings.

Four or more poles; splash-proof; ball bearings.

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

E-M

SPECIALISTS IN
BIG MOTOR ENGINEERING

1300-TPA-2057

NEWS ABOUT PEOPLE

Hartsock Assigned New Duties by Ohio Utility

Announcement has been made of the appointment of Earl Hartsock to the position of superintendent of electric

E. HARTSOCK

operations for the Columbus and Southern Ohio Electric Co, Columbus, Ohio.

Mr Hartsock entered the employ of the Columbus utility in 1926, starting as a repairman in the electrical repair shop. Three years later he was assigned to substation operation and remained in that capacity while completing his education at Ohio State University. He received an E. E. degree in 1934.

More recently he has been engaged in various engineering and operating work and in 1946 was appointed assistant general superintendent of operation.

•

▶ ROYDEN M. CAMPBELL, formerly with Canadian Westinghouse Co, Ltd, recently joined the staff of A. Edward Simpson, consulting electrical engineer, Vancouver, B. C. Mr Campbell started with Canadian Westinghouse in 1945 as sales engineer, specializing in lighting and special products. Previously he had been identified with the Boeing Aircraft Co. In his new connection Mr Campbell will engage in the preparation of electrical plans and specifications for public buildings, schools, industrial plants and other structures.

▶ S. J. PETTERSEN has been appointed vice-president and treasurer of the Mississippi Valley Public Service Co at Winona. R. M. HOWARD, vice-president, has retired. Mr Pettersen started with the utility in 1928 as a construction auditor and in 1938 was appointed treasurer and assistant secretary. At the time of his promotion to a vice-presidency he was also elected to the board of directors. Mr Howard had been with the company for 37 years and was identified with the electrical industry for the past 59 years. He has always been active in association work, having served as president of the North Central Electric Association in 1923.

•

Scientists Receive War Aid Medals from Government

Several scientists, who headed government research projects during World War II, have received the Medal for Merit, representing the President's highest award to civilians.

Among the recipients were Dr Chauncey G. Suits, vice-president of the General Electric Co in charge of the research laboratories at Schenectady. As chief of the Radio and Radar Countermeasures Division, he headed the effort to defeat the enemy use of radar and radio communications.

Dr Zay Jeffries, vice-president of GE in charge of the chemical department, Pittsfield, Mass. He was vice-chairman of the War Metallurgy Committee of the National Defense Research Committee.

Dr Herbert E. Ives, research consultant of the Bell Telephone Laboratories, for many years. He was cited for his "brilliant" work in development of equipment using infrared rays.

Dr Irving Langmuir, associate director of the GE research laboratories, was cited for his work with toxic smoke, screening smoke and smoke filters in gas masks.

•

▶ C. HERALD CAMPBELL has been appointed personnel director of Pacific Power & Light Co. He has just completed two years as assistant personnel director. With the Kaiser shipyard at Swan Island during the war as contract engineer, Campbell was responsible for all sub-contracting and handled claim adjustments.

Boston Edison Co Appoints Buckley Rate Engineer

John E. Buckley, Jr, has been appointed rate engineer for the Boston Edison Co. He will be associated with the rate research and statistics department.

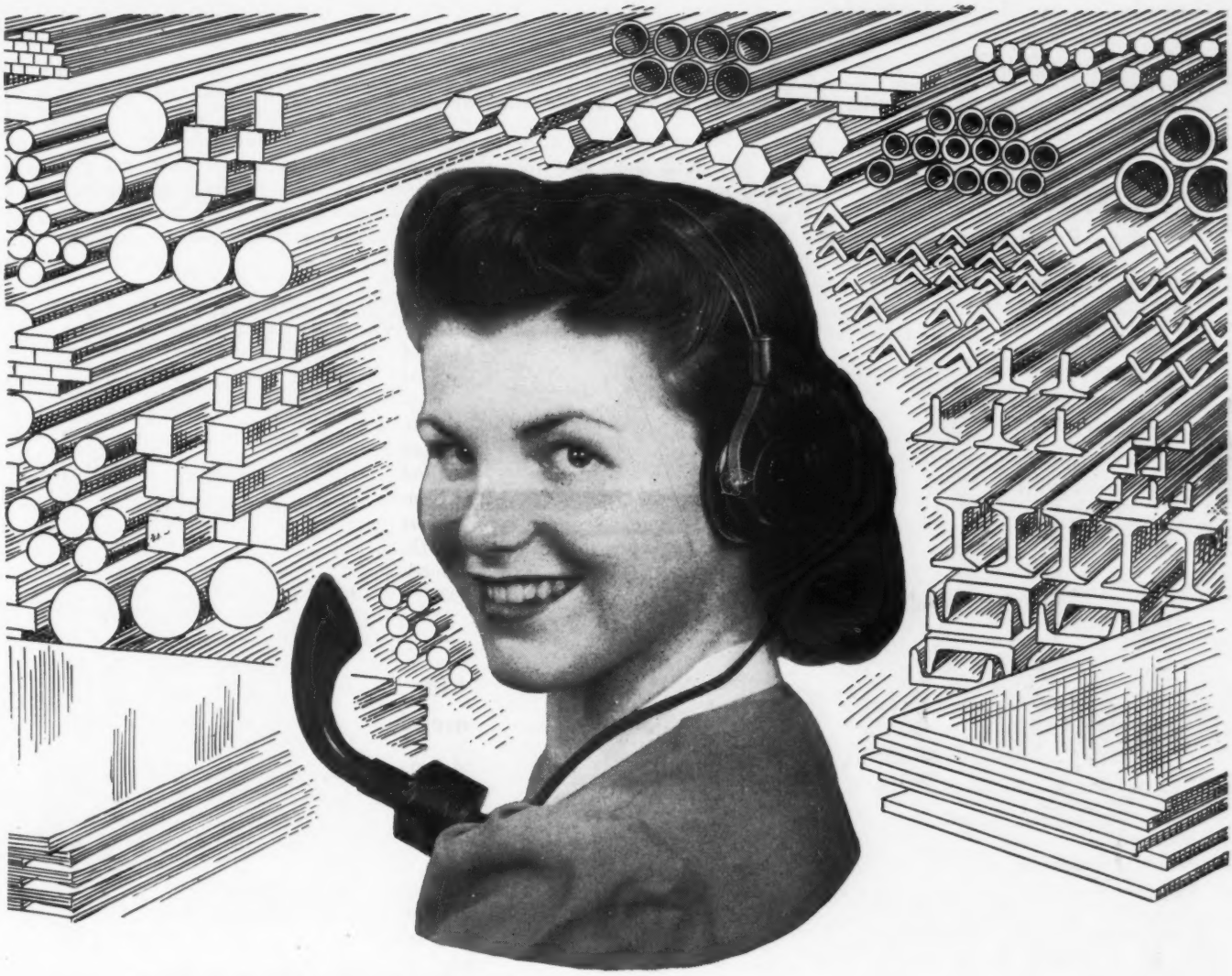
Mr Buckley was graduated from the Massachusetts Institute of Technology

J. E. BUCKLEY, JR

in 1921 in electrical engineering. He has been more than 20 years with the Massachusetts Department of Public Utilities as rate engineer, assistant engineer and director of gas, electric and water utilities. Formerly he was active in construction engineering on power projects and was connected with the Consolidated Edison Co, New York, and the Charles H. Tenney organization, Boston.

•

▶ DR KARL SPANGENBERG, professor of electrical engineering at Stanford University, California, will be granted a leave of absence for a year to direct the electronics activities of the Office of Naval Research. Dr Spangenberg will spend several days in Washington each month during the spring and summer months and will report for duty September 1. He will return to Stanford in the Fall Quarter next year. Dr Spangenberg currently holds an Office of Naval Research contract to study properties of receiver oscillator tubes and circuits of types used in microwave radio and radar. Prior to joining the Radio Research Laboratory staff, he was a technical consultant with the



when it comes to steel—

Our Business is YOUR Business

You can simplify steel purchasing for every power generating requirement with a call to your nearby Ryerson plant. We plan our stocks to meet your needs and, when it comes to steel, our business is your business.

For almost a hundred years Ryerson specialists have been working with the utilities and their equipment manufacturers—quickly supplying the right steel for every application. Now, during times of great demand, Ryerson stocks and Ryerson experience are especially helpful.

Whether your requirements are measured in pounds or tons, they receive the immediate attention of experienced steel men. And if the steel you need is not readly available from stock, Ryerson know-how goes to work. Often we can suggest a practical alternate steel.

So contact Ryerson when you need steel for new construction or maintenance. Let one order to Ryerson, one invoice and one shipment do the job; save you time and money.

Joseph T. Ryerson & Son, Inc. Plants: New York, Boston, Philadelphia, Detroit, Cincinnati, Cleveland, Pittsburgh, Buffalo, Chicago, Milwaukee, St. Louis, Los Angeles, San Francisco.

PRINCIPAL PRODUCTS

BARS — Carbon & alloy, hot rolled & cold finished
STRUCTURALS — I beams, H beams, channels, angles, tees, zees
PLATES — Sheared & U. M., Inland 4-way Floor Plate, etc.
SHEETS — Incl. Allegheny stainless, many others
TUBING — Welded & seamless boiler tubes, mechanical tubing
MACHINERY & TOOLS — For metal fabricating & boiler shops, etc.

RYERSON STEEL

Office of Scientific Research and Development. He is the author of a book on vacuum tubes, published recently by the McGraw-Hill Book Co.

•

Orrin E. Wolf Elected Vice-President, Hotpoint

Orrin E. Wolf has been elected vice-president of Hotpoint Inc, Chicago, and manager of the newly established

O. E. WOLF

commercial cooking equipment division. The move marks a final step in decentralizing the commercial cooking equipment operations from the company's household appliance business, James J. Nance, president, stated in making the announcement.

Mr Wolf has been a vice-president of Zenith Radio Corp, Chicago, and previously he was for many years an executive of Frigidaire division, General Motors Corp, Dayton, Ohio, in commercial refrigeration.

•

▶ ROBERT W. MCKINLEY, who, until recently was on the staff of the Illuminating Engineering Society at its headquarters in New York, has joined Pittsburgh Corning Corp's newly formed development group. Mr McKinley is widely known as editor of the recently published IES Lighting Handbook. He specialized in lighting application and educational work with Sylvania, Westinghouse and the U. S Navy Department in Washington.

▶ CARL L. RICHEY and HAROLD W. WARMOTH have been appointed assistant general managers of the Sacramento, Calif, Municipal Utility District. Mr Richey has been serving as administrative officer and assistant to the general manager, and Mr Warmoth has been general superintendent in charge of the operating department of the district.

Award Honorary Degrees to More Electrical Men

Additions have been made to the list of electrical men who recently have been awarded honorary degrees (*EW*, June 19, p 131). Most recent recipients include:

CHARLES E. WILSON, president of the General Electric Co, doctor of laws, Williams College.

HENRY B. WOOD, chief electrical engineer of the Stone & Webster Engineering Corp, Boston, doctor of engineering, Purdue University. In presenting him for the degree reference was made to Mr Wood's professional services "world-wide in their scope," and it was further stated that "as a designer and builder of electric power and manufacturing plants for both industrial and war materials production, Mr Wood has rendered distinctive services to this country and its industries." The diploma characterized the recipient as "Distinguished engineer and executive, recognized for his contributions to our knowledge and control of electrical power, honored for service to our nation during two wars."

CARROLL L. WILSON, general manager of the Atomic Energy Commission, doctor of science, Williams College.

GEORGE R. LANGLEY, chief engineer, Canadian General Electric Co, doctor of science, Union College.

ARTHUR M. HILL, chairman of the National Security Resources Board, doctor of engineering, Drexel Institute of Technology.

ERNEST H. PEABODY, president and founder of Peabody Engineering Corp, doctor of engineering, Stevens Institute of Technology.

VINCENT J. SCHAEFER, GE research laboratory, doctor of science, Notre Dame University. Mr Schaefer is the scientist who discovered a method for producing snow and rain from supercooled clouds by seeding them with pellets of dry ice. He gained widespread attention and received the name "snowmaker" in 1946, when he used his newly developed method to transform a four-mile-long cloud over Massachusetts into snow.

•

▶ OSCAR GAARDEN, manager of valuation sales, Northern States Power Co, Minneapolis, Minn., has retired. He has completed 30 years of continuous service with NSPCO. Mr Gaarden first entered the public utility field as consulting engineer for the Manitoba Utilities Commission at Winnipeg and served that board for the next two years. In 1916 he transferred to the Wisconsin-Minnesota Light & Power Co at Eau Claire, Wis., and was placed in charge of the distribution system of that company. The following year Mr Gaarden became identified with Northern States in the distribution department as assistant engineer and three years later was transferred to the sales department as valuation engineer.

•

H. J. Newton Named V-P, National Electric Products

Harold J. Newton, sales manager of the National Electric Products Corp, Pittsburgh, has been elected a vice-

H. J. NEWTON

president of the corporation. The new vice-president and general sales manager has devoted his entire business career to the marketing of the company's electrical wire, cable, conduit and raceways.

His first position was in 1912, when he became a salesman for I. A. Bennett & Co, Chicago, sales agents for National Electric. He went to Pittsburgh in 1929 as eastern district sales manager for National Electric, was transferred to San Francisco in 1931 and became western sales manager in charge of eleven western states. In 1943 he was appointed sales manager, returning to the company's general offices in Pittsburgh.

•

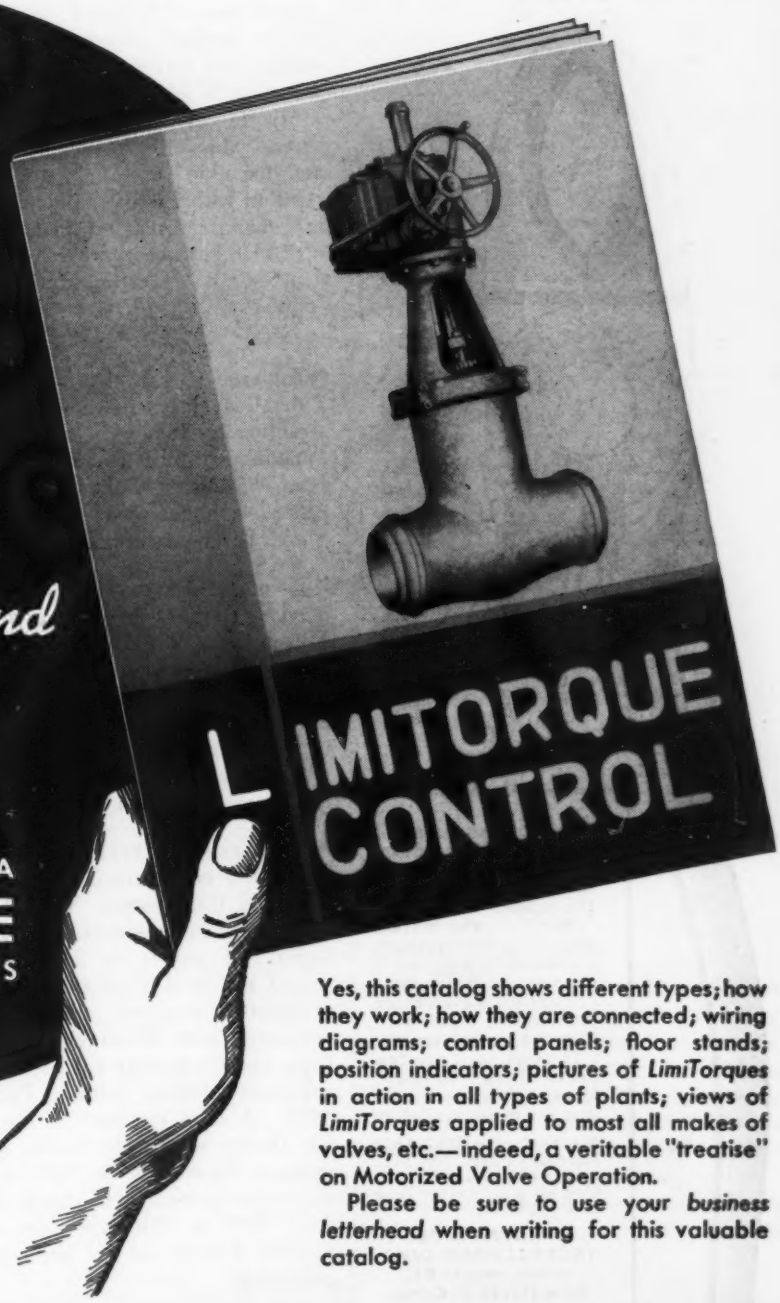
▶ HAROLD B. TYREE, assistant to the president, has been made responsible for all of the Detroit Edison Co's transactions with unions. LYNDEN J. KAUFMANN, formerly union relations adviser, has been appointed to the president's staff as deputy union negotiator. Mr Tyree joined the company in 1919 and for the past six years has been concerned with labor matters as an assistant to the president. Prior to that he was fuel purchasing agent and latter supervising engineer of the research department. Mr Kaufmann became

for Engineers Interested in Valves and Piping . . . Steam, Water, Oil, Gas, etc.

Here's the Book you've been waiting for:.

96 Pages *of Illustrated, Diagrammatic and Tabular Matter regarding..*

PHILADELPHIA
LIMITORQUE
VALVE CONTROLS

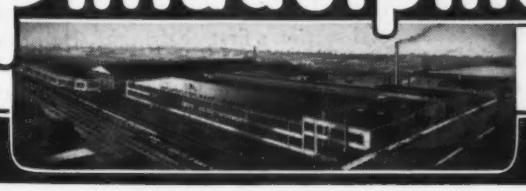


Hundreds upon hundreds of valves on land and sea—for every conceivable use, are being safely, speedily and dependably opened and closed by *LimiTorques* day in and day out.

Yes, this catalog shows different types; how they work; how they are connected; wiring diagrams; control panels; floor stands; position indicators; pictures of *LimiTorques* in action in all types of plants; views of *LimiTorques* applied to most all makes of valves, etc.—indeed, a veritable "treatise" on Motorized Valve Operation.

Please be sure to use your *business letterhead* when writing for this valuable catalog.

Philadelphia Gear Works, INC.



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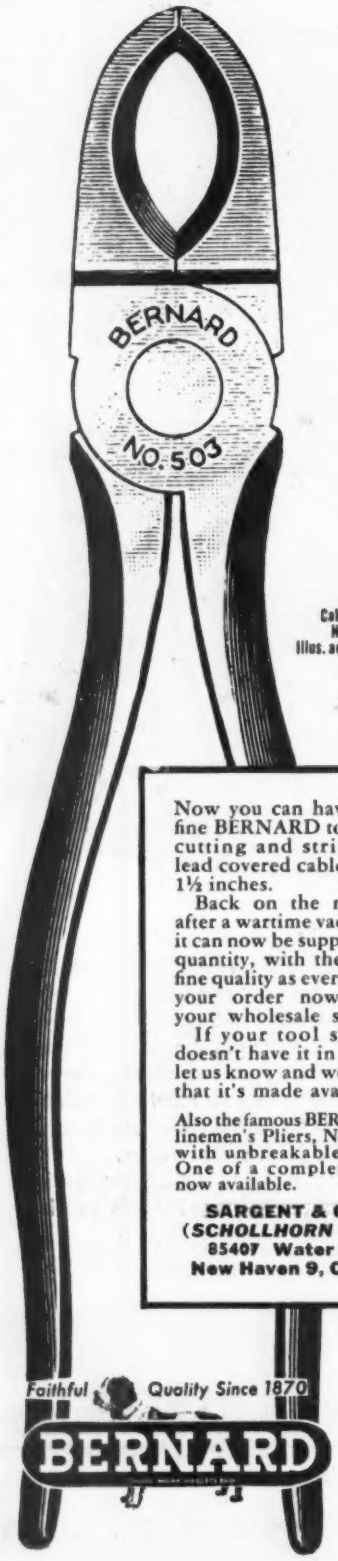
NEW YORK • PITTSBURGH • CHICAGO
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

GOOD NEWS

BERNARD

CABLE SHEATHING CUTTER AND STRIPPER IS BACK!



Now you can have this fine BERNARD tool for cutting and stripping lead covered cable up to 1½ inches.

Back on the market after a wartime vacation, it can now be supplied in quantity, with the same fine quality as ever. Place your order now with your wholesale source.

If your tool source doesn't have it in stock, let us know and we'll see that it's made available.

Also the famous BERNARD linemen's Pliers, No. 512, with unbreakable head. One of a complete line now available.

SARGENT & CO.
(SCHOLLHORN DIV.)
85407 Water St.,
New Haven 9, Conn.

identified with the company in 1924 and has been in personnel work for many years. Since 1942 he has been actively engaged in union relations work.

•

W. E. Harvey Made Director, Product Research, Dolph

Announcement has been made by the John C. Dolph Co, Newark, N. J., of the appointment of Walter E. Harvey as director, product development and research. Mr Harvey joins the Dolph Co with a wide background of experience.

Mr Harvey has been associated with several companies in the chemical field, and for nine years held an important position with one of the country's leading manufacturers of insulating varnish. He has been active in the American Society for Testing Materials.

•

▶ RICHARD C. LOWRIE, for many years a detail engineer for power plant construction for Idaho Power Co, has been appointed resident engineer at the company's $12,000,000 hydroelectric project now under construction on the Snake River near Bliss, Ida.

▶ HERBERT C. DAVIDSON has retired as a vice-president of the Consolidated Edison Co of New York, Inc. Mr Davidson joined the company in 1938, when he was elected chief accounting officer. He became a trustee in 1943, a member of the executive committee of the board of trustees and has been secretary of the board since 1934.

▶ CHARLES G. DURFEE, director of fire protection engineering, Pyrene Manufacturing Co, Newark, N. J., has been made a vice-president. Mr Durfee began his career in 1920 when he joined the New York Edison Co as a combustion engineer. Later he was connected with Westinghouse Electric Corp and the Society for Electrical Development before joining Pyrene in 1928. A sales engineer at the outset, Mr Durfee was made manager of the systems department in 1930, assistant to the vice-president in charge of sales from 1938 to 1945 when he was appointed director of fire protection engineering.

▶ FRED W. ROTH, who has been associated with the industrial storage battery industry for 15 years, has been made vice-president in charge of the Trenton plant operations for the Gould Storage Battery Corp. Mr Roth was works manager of the Trenton plant of the Storage Battery Division of Philco Corp when that division was merged with Gould last year.

▶ JOHN H. WARD has been elected president of the Palmer Electric & Manufacturing Co, Wakefield, Mass. He succeeds the late Granville E. Palmer. Mr Ward was educated at Wentworth Institute, Boston, and joined the company 21 years ago as a stock control man. Later he became production manager, then sales manager, and for the past ten years has been general manager. He was elected to the board of directors five years ago. ARTHUR A. TERRIO, who joined the company 18 years ago, and who has been assistant treasurer and a director for ten years, is now treasurer of the company.

▶ C. A. ORR has relinquished his duties as president and general manager of the Union Metal Manufacturing Co, Canton, Ohio, and was reelected board chairman, which office has been broadened in certain executive powers. C. A. STREB, who has been with the company since 1926 and has served as secretary for the past 11 years, succeeds Mr Orr as president. E. W. RIEMENSCHNEIDER, formerly chief engineer has been named vice-president in charge of engineering; D. B. HANNA, assistant general manager, was made general manager and A. R. JONES, assistant secretary, was made secretary. Before joining Union Metal, Mr Streb was general superintendent of the Carnahan Tin Plate & Sheet Co. Mr Riemenschneider joined the company in 1926 and is responsible for many of the developments of special processes and product improvements. He had been chief engineer since 1940. Mr Hanna was made general sales manager in 1935 and assistant general manager in 1940.

▶ THOMAS F. KELLY has retired as director of dealer relations of the Hoover Co, North Canton, Ohio, after an association of nearly 30 years. Mr Kelly joined the Hoover organization in 1919 as sales manager for its Canadian company, later becoming vice-president in charge of sales. Subsequently he was transferred to Chicago, then to home offices at North Canton to take charge of the public utility division. In 1931 he became director of dealer relations. Before entering the manufacturing field, Mr Kelly was identified with the utility industry. Born in Hamilton, Ontario, he entered the employ of the Cataract Power Co (later the Dominion Power & Transmission Co) in 1900 and, advancing rapidly, was appointed sales manager of the power and light division. He became active in the Canadian Electrical Association and was its commercial section's first chairman. He organized the Hamilton section of the old National Electric Light Association and was its first president. In 1913 he moved to Dayton, Ohio, to join the Dayton

COAL PREPARATION at 1000 TONS per HOUR with TWIN AMERICANS

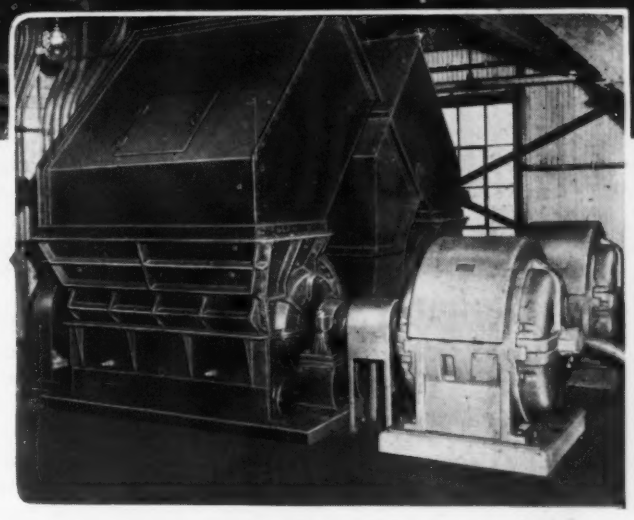
Ohio Power Company
Tidd Plant at Brilliant, Ohio

and THE *COMPLETE* CRUSHING UNITS OCCUPY ONLY 12'x12'x12'

110,000 kilowatt output represents converting 1200 tons of coal per day into power . . . Continuous pulverizer feed from bunkers kept at constant level of ¾" by conveyors from the two "Type S, No. 60" American Ring Crushers which reduce the 16" ROM bituminous coal.

Direct-connected (two 200 HP 720 RPM motors), the Americans employ efficient shredder ring action with an unusually conservative power demand.

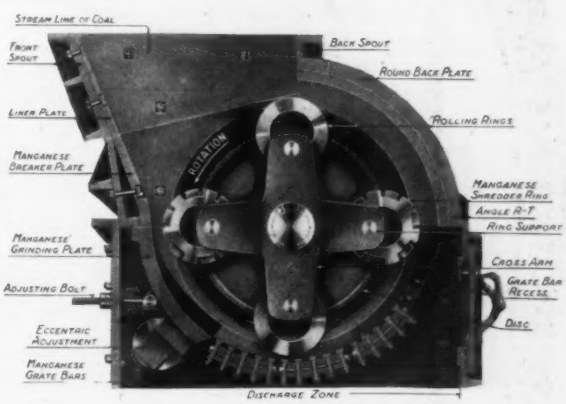
The uniform product and the dependability of Americans are considered essentials to the unfailing, high output of the Ohio Power Co. and other power plants throughout the world. Americans offer a complete crushing plant in one compact unit no auxiliary crushers or refuse picking operations are required.



Note the compactness of area and headroom in which these two direct motor-connected Type 60S Americans are installed including by-pass between.

Send for the facts on efficiency of coal preparation in power plants with American Crushers

Cross-Section shows Americans patented shredder ring action. Each shredder ring revolves on its own shaft and automatically deflects from tramp iron.



American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1133 MACKLIND AVE.
ST. LOUIS 10, MO.

serve growing electric loads economically

with system planning!

Here's how EBASCO engineers can help you plan the expansion of your system — to serve adequately present and expected loads and be readily adaptable to potential growth and technological advances. They take all factors into account, assuring you minimum overall operating costs and maximum useful life.

EBASCO specialists study your present system, markets, load growth and customer service requirements. They coordinate the planning of required additions and revisions to the three components of the system — *power supply — transmission — distribution.* They bring a fresh *objective* approach and application of advanced practices to each problem they tackle — along with diversified experience in the development and operation of all types of utility systems and power pools.

EBASCO engineers will develop several alternative plans with comparisons of investments, investment costs, operating costs, evaluated service and other factors. You get a complete report on which management can act with assurance. It advises you on *when, what* and *where* to build. *Write for a booklet describing* EBASCO *services and facilities.*

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Accounting • Appraisal • Budget • Consulting Engineering
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Rates & Pricing • Research • Sales & Marketing • Taxes • Traffic

Power & Light Co. He was the first chairman of the commercial section of NELA and first chairman of its lighting sales bureau.

▶ WARD R. SCHAFER has been named vice-president and general manager of the Coolerator Co, Duluth, Minn. WILLIAM C. CONLEY, JR, has been appointed sales manager and will be directly responsible for all marketing activities. Mr Schafer was associated with Hotpoint, Inc, for more than 20 years, serving in a number of executive positions, including divisional sales manager, general sales manager and as vice-president. Mr Conley started in 1930 with Potomac Edison Co, which was among the pioneers in the aggressive merchandising of major appliances. He joined Hotpoint in 1945 as national sales manager.

▶ THOMAS J. MANNING has been elected a vice-president of the Howell Electric Motors Co, Howell, Mich. Mr Manning joined the Howell organization in 1946 and has served as the assistant to the president since that date. Previously he had served as comptroller of Wright Aeronautical Corp, Cincinnati Division, and Graham Paige Motor Corp. Earlier in his career he was engaged in industrial engineering and at one time served in the capacity of vice-president and treasurer of the New Mexico Lumber & Timber Co.

▶ JOSEPH M. SMITH, formerly technical director for the Fluorescent Lighting Association, and since 1945 manager of the lighting division of the Federal Electric Co, Inc, Chicago, has resigned. Mr Smith will remain in the fluorescent lighting field, transferring his activities to the Los Angeles area.

OBITUARY

▶ JOHN MILLS, physicist and engineer, who retired in 1945 after 20 years as director of publication at the Bell Telephone Laboratories, New York, died on June 14 in Rochester, N. Y., while visiting his son. Mr Mills joined the American Telephone & Telegraph Co in New York in 1911 as a transmission engineer. In 1925 he became director of publication for the Bell laboratories. Mr Mills was born in Morgan Park, Ill. He was the author of many engineering and scientific papers and wrote a dozen books. He planned the magazine, "Bell Laboratories Record," as a medium for describing the research and development work by A. T. & T. engineers. Since his retirement, Mr Mills has been an advisor to undergraduates at the California Institute of Tech-

Where and How to Use *Crapo* Steel Conductor

Ask for This Guide to Low-Cost Rural Lines!

If future plans call for the extension of rural service, be sure to ask for a copy of this Manual! A study of its contents will show where and how *Crapo* Steel Conductors can be used to profitable advantage in rural distribution systems.

• This illustrated book contains pertinent data on the electrical characteristics and electrical performance of these unique conductors. It shows how construction costs can be reduced and final sag and tension data, describes construction practices, cites typical installations.

Crapo Steel Conductors are especially applicable to rural taps and branches where construction and maintenance costs are important considerations. The experience of a number of leading utilities over a period of years shows conclusively that *Crapo* Steel Conductors are giving dependable, economical and efficient service on thousands of miles of line in rural areas.

Crapo Steel Conductors are distributed by Graybar Electric Company, Inc. Ask a Graybar representative for a copy of the *Crapo* Steel Conductor Manual or write direct for Manual No. 110-C.

Indiana Steel & Wire Company
Muncie, Indiana

Crapo Steel Conductors

nology. He was a fellow of the American Institute of Electrical Engineers, the Institue of Radio Engineers and the American Physical Society.

•

John E. Benton

John E. Benton, 73, general solicitor of the National Association of Railroad and Utilities Commissioners for 27 years, died on June 21 in Washington, D. C. He had been ill for several weeks.

As chief legal officer for NARUC, a position which he resigned in 1945, Mr Benton was influential in framing both federal and state regulatory legislation. He frequently intervened on behalf of the Association and state commission in proceedings before various federal regulatory bodies.

A native of New Hampshire, he received his legal degree from Boston University in 1898. He served as city solicitor of Berlin, N. H., from 1901 to 1903, before entering private law practice in Keene, N. H. As a member of the New Hampshire Legislature in 1907-08, he helped draft the state's Public Service Act. He also served as solicitor and mayor of Keene before his appointment to the New Hampshire Public Service Commission in 1911.

He went to Washington in 1918 as a member of the Interstate Commerce Commission's legal staff. He became general solicitor for NARUC later that year. After his retirement from the latter position, he was made advisory counsel for the Association and represented NARUC in recent Congressional hearings on proposed amendments of the Federal Power and Natural Gas Acts.

He was a member of the American Bar Association, the Interstate Commerce Commission Practitioners Association, the Federal Communications Commission Bar Association and the American Judicature Society.

•

▶W. Galbraithe Mitchell, assistant manager of the River Works, General Electric Co, Lynn, Mass., died at Salem, Mass., on June 21. Born in New York, he was graduated from Princeton in 1896. Mr Mitchell's career with GE included an early connection with lighting developments in Europe, and a long period in labor relations work. His reputation in the latter field was nationwide.

▶ Carl M. Sharpe, 57, member of the Connecticut Public Utilities Commission since 1946, died suddenly in Pomfret, Conn., on June 16. He was born in Pomfret and had been a member of the state legislature for three terms, and also state treasurer.

MAINTENANCE COSTS SLASHED
Many Years of Service Prove Koppers Pressure-Creosoted Poles Key to Big Savings
Koppers Pressure-Creosoted Poles, the treatment proven over many years of service, are a logical part of intelligent Maintenance Saving Programs. These Poles, acknowledged as most dependable, have a record of long life and low costs. Users report installations 30 to 40 years old still in good condition. Prompt delivery from conveniently located treating plants and ample facilities permit stocking of all needed quantities and sizes for contract treatment or out-of-stock shipments.
KOPPERS
PRESSURE-TREATED WOOD
KOPPERS COMPANY, INC.
PITTSBURGH 19, PA.

MANUFACTURERS and MARKETS

Third-Round Wage Increases Continue; Some Manufacturers Raising Prices

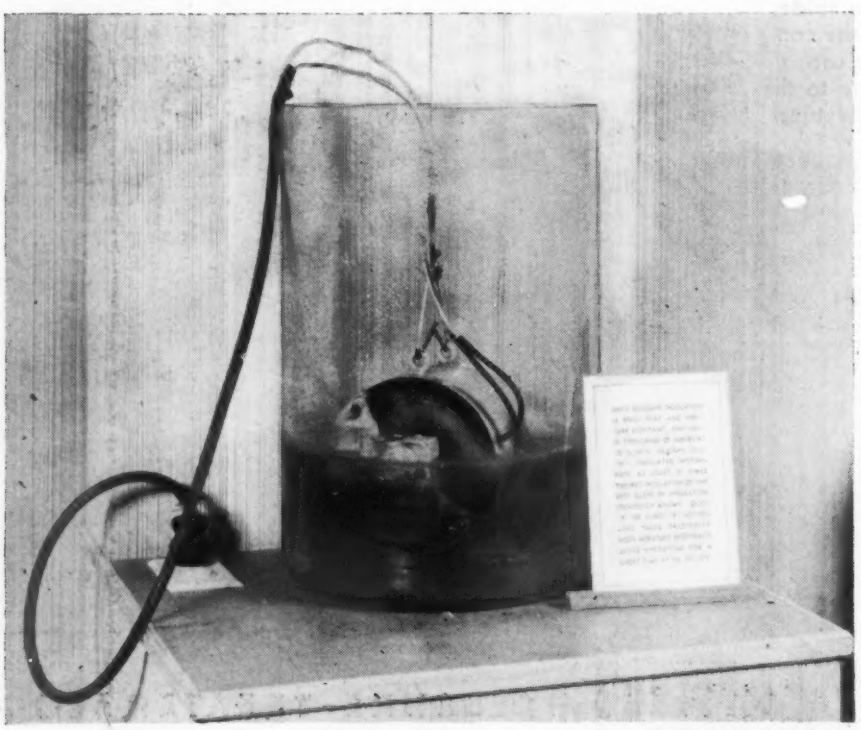
Wage increases by electrical manufacturers were mounting last week (June 25) as the third round continued. In some cases, price increases were announced simultaneously.

Early in the week, the United Electrical, Radio & Machine Workers, CIO, got in a plug for its resistance to the Taft-Hartley Act with the announcement that it had won annual wage boosts totalling $100,000,000 for 400,000 members. This, it said, came in spite of its refusal to submit non-Communist affidavits for its officers, a prerequisite to recognition by the National Labor Relations Board.

Six months ago, there was a lot of question as to whether UE would be able to hold its preeminent position in the industry under the impact of NLRB's refusal to certify unions which failed to qualify under Taft-Hartley. On this point UE President A. J. Fitzgerald noted that 72 additional employers had been signed by UE since the act took effect a year ago. Fitzgerald predicted UE would win pay increases for another 150,000 workers, also. Thus far it has won increases from GE, Westinghouse, General Motors, Sylvania, and Phelps-Dodge.

Allis-Chalmers was third of the big three to fall in line last week. Its increase fits closely to the GE-Westinghouse pattern, ranging from 9 to 15 cents per hour for hourly workers. Salaried employees were to receive a minimum boost of $16 per month or 8%, whichever is higher. The offer affects 33,000 employees in nine plants and would cost the company an estimated $8,500,000 yearly. Similar increases went into effect for hourly workers unrepresented by unions and for salaried people earning less than $6,000 yearly.

Westinghouse continued its wage-boosting by giving $16.47 to $40 monthly increases to salaried workers represented by an independent union. General Cable Corp granted an 8% boost, with a 9-cent minimum, to workers in its Perth Amboy and Bayonne, N. J., and St. Louis plants. The contracts will run for two years from July 1, and were made with IBEW, AFL.



Dow-Corning Corp. Photo

"DUNKING MOTOR" was featured by Dow Corning Corp at recent Industrial Electrical Show at Detroit. The motor, which ran at approximately 150 deg C, was dunked in water on a 60-second continuous cycle without damage. Silicone (Class H) insulation was used.

Copper Workers Get Raise

Phelps-Dodge Copper Products Co workers get 12 cents an hour more under an agreement with UE which covers workers at three plants. It runs for two years and may be reopened next year for wage discussions.

Rome Cable Corp gave an 8% increase to all hourly paid workers and salaried employees will get the same boost on July 1. It is the eighth wage increase by company since Feb, 1941.

At the Scovill Manufacturing Co, Waterbury, Conn., brass and copper concern, non-union employees were given an 8¼% pay increase. Negotiations were continuing with Local 825, Mine & Smelter Workers, CIO, which represents the bulk or over 6,000 employees.

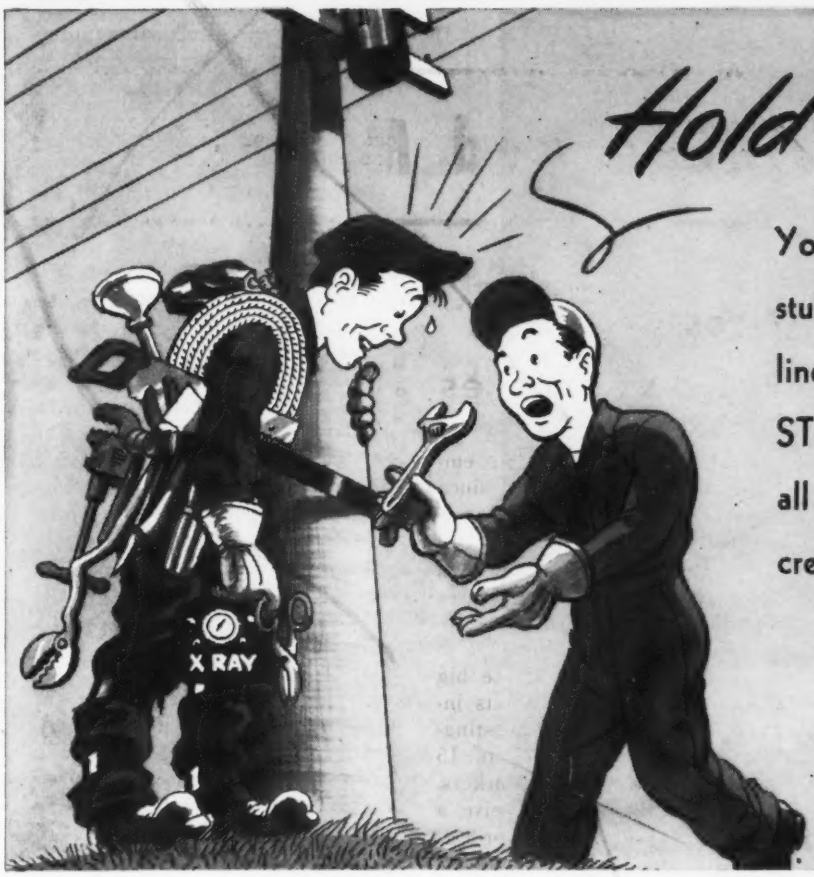
Another pay raise was gained by UE in a two-year contract with the Formica Insulation Co. The contract, which is effective as of May 28, provided a seven-cent hourly general increase for all employees covered by the agreement. A provision was included to permit reopening of negotiations on wages at the end of the year.

Aluminum Strike Avoided

The Aluminum Co of America avoided a strike at the last minute when the United Steel Workers of America, CIO, and the Aluminum Workers of America, AFL, agreed to a two-year contract which embodies wage boosts of 10 to 16 cents per hour. The contract may be opened once for wage negotiations in May, 1949.

In Oak Ridge, Tenn., the long-continued struggle over wages for atomic workers was ended when the union ratified a one-year pact calling for increases of 6.5 to 40.5 cents per hour.

An independent union of Sangamo Electric Co workers voted down an 8% wage offer which called also for a 4% boost to piece workers. A union official indicated that an 8% boost with a 9 cent minimum—such as has been the



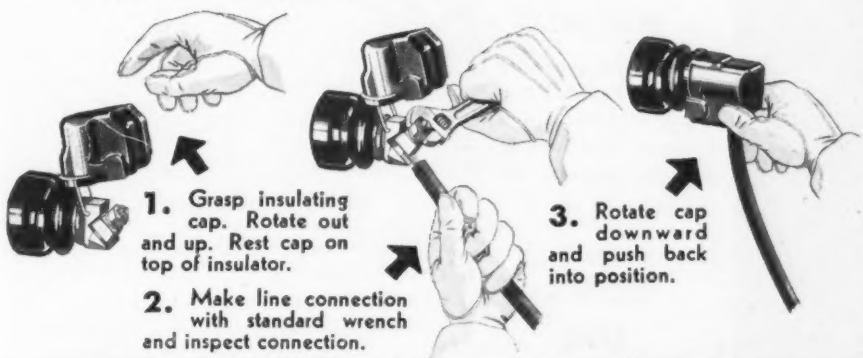
Hold it, George!

You don't have to carry all that stuff up the pole just to make a line connection. There's a POLE STAR* Transformer up there, so all you'll need is this standard crescent wrench.

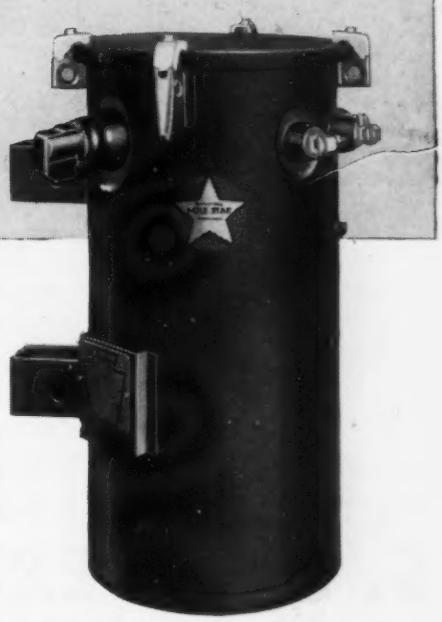
"... And throw away that X-ray gadget, George. You won't need that either because you'll be able to see what you're doing when you're making your line connections up there."

When the insulating cap on the High Voltage sidewall bushing is swung to the open position, the solderless connector is completely exposed so the lineman can see the connection. No tools are needed to open and close the insulating cap. A standard wrench is the only tool required to connect the line to the terminal. (A wrench is the best tool for making a reliable electrical connection.)

Solderless connectors on high voltage, sidewall bushings are designed to allow line leads to issue at a downward angle in order to facilitate installation when replacing pocket-bushing transformers with the New POLE STAR Transformers.



1. Grasp insulating cap. Rotate out and up. Rest cap on top of insulator.
2. Make line connection with standard wrench and inspect connection.
3. Rotate cap downward and push back into position.



Embodying a new wound core design with an inherent low exciting current, POLE STAR Transformers are made in sizes 25 Kva and below, 14400 volts and below, single phase, 60 cycles, OISC, conforming to EEI-NEMA Standards.

*P.S. let the POLE STAR be your guide

Product Of Long Experience

Safe Thrifty And Reliable

POLE STAR

Pennsylvania TRANSFORMER COMPANY

PITTSBURGH 12, PENNSYLVANIA

SAVE MONEY!

Flexibal wooden guy guards cost less than other types — give full protection longer.

SAVE TIME!

7 foot Flexibal guy guard takes just 2 minutes to install — then lasts for years.

Put *Flexibal* guy-wire guards on your standards list . . NOW!

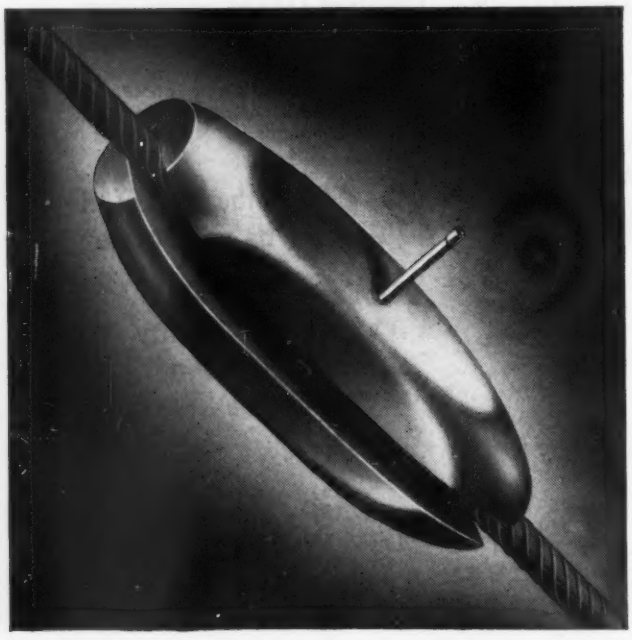
Every organization that has standardized on Flexibal guy guards has continued their use. Made of smoothly rounded hardwood and aluminum coated for lasting visibility, Flexibal guy guards provide flexible, lasting protection. They're packed in small easy-to-carry cartons, and there's only one nail to drive. May we send you free trial sample. No obligation of course.

FREE trial set of FLEXIBAL GUY GUARDS

SET of Flexibal guy guards for 7 foot length will be sent at no cost for test. Write on your business letterhead.

S. E. OVERTON CO.

SOUTH HAVEN, MICHIGAN



EASY TO INSTALL

Packed in easy-carry carton, Flexibal guy guards take only a couple of minutes to install. They save you money.

LONG LIFE

Lower first cost, lower installation cost, *and* longer years of trouble-free service make Flexibal the guy guard for you.

pattern elsewhere in electrical manufacturing—probably would be acceptable.

Sylvania Electric Products offered an 8% boost to 7,500 organized employees and put it into effect for 2,500 which are not organized.

In the price field, GE extended the increases which came when it offered UE a 9 to 15 cent wage boost. Latest items to be raised in price are integral motors and generators—upped 5%—and industrial control equipment, boosted 10%. The new prices were effective July 1. Alcoa accompanied its wage boost with a one-cent hike in the cost of aluminum. It was described as the first upward movement in basic aluminum prices in 11 years. And General Cable accompanied its wage hike with a price increase. It averages somewhat over 5%, but runs from nothing on some items to 13% on others. It is the first price change by the company since April, 1947, when prices were cut 6%.

A general upward price movement in copper and brass began this week (June 28). American Brass Co took the lead with an increase of copper product prices of 1 to 1½ cents. Higher costs of supplies and higher wages were given as the reason for the increase. Sources close to the market said other companies will be forced to follow.

•

Electromaster Strike Ends; New Contract Voted

Striking employees of Electromaster Inc, Mount Clemens, Mich., have voted approval of a new contract calling for an 11-cent hourly pay increase, of which 8 cents will be retroactive to last January 13.

Acceptance of the two-year contract, based on the General Motors agreement, ended the 43-day strike. It calls for a 3-cent increase, June 1, 1949, and will run to June 1, 1950.

Of the 11-cent increase, 6 cents is fixed for the duration of the contract, with the remainder subject to variation according to the cost of living index.

•

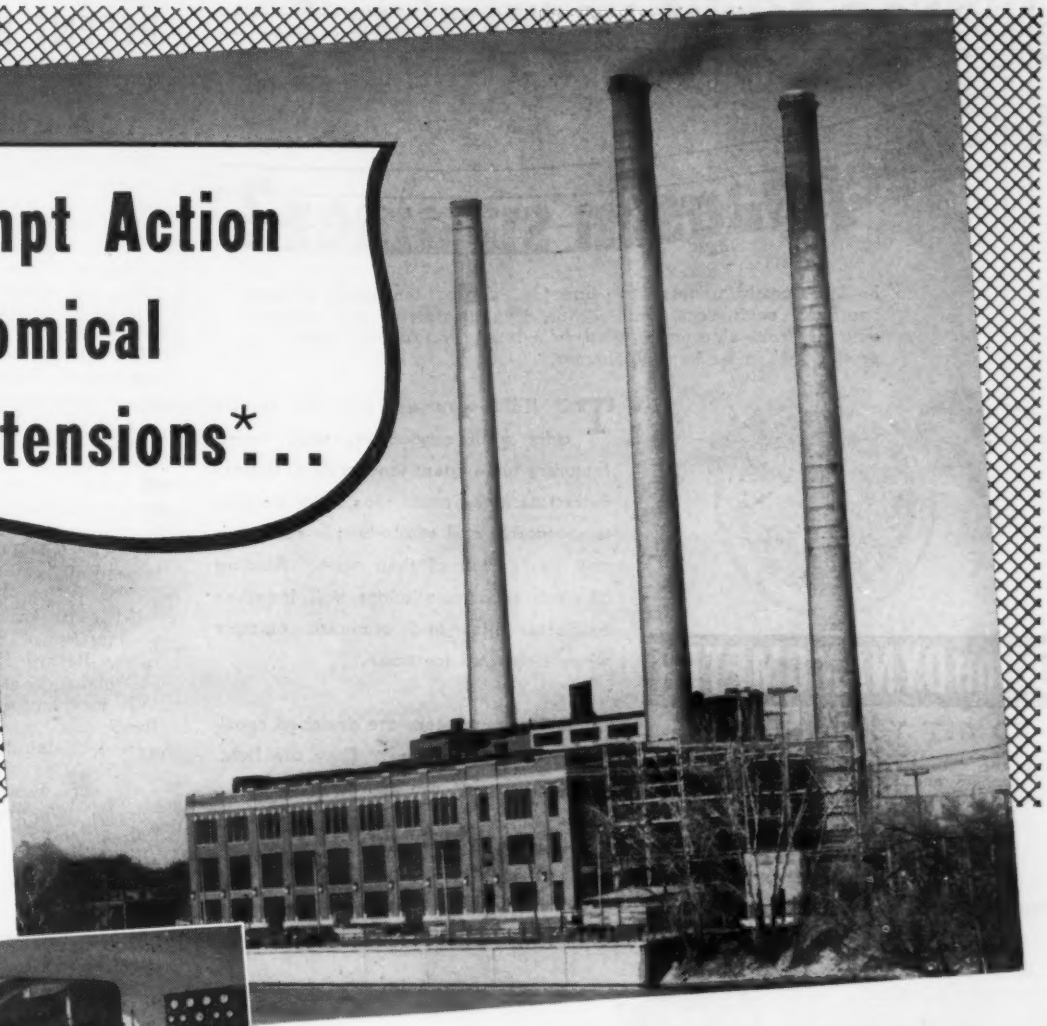
Redmond Co Purchases Holtzer-Cabot Electric

Redmond Co, Inc, Owosso, Mich., has purchased the Holtzer-Cabot Division of the First Industrial Corp.

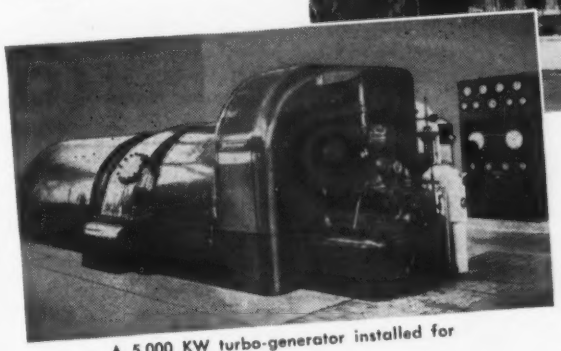
Holtzer-Cabot Electric Co, located in Boston, Mass., is one of the oldest manufacturers of motors, having been in existence almost 75 years.

Frank C. Campbell, president of Redmond, will assume the direction of both companies, and Holtzer-Cabot will be known as Holtzer-Cabot Division of Redmond Co, Inc.

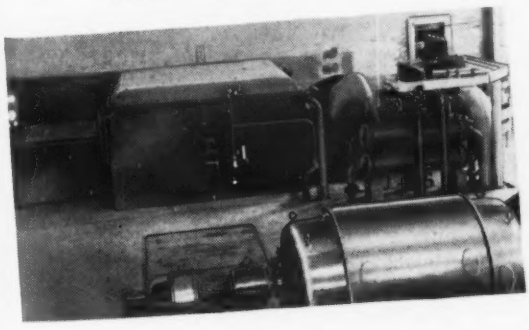
For Prompt Action on Economical Plant Extensions*...



To the plant of a large midwestern utility, shown at right, Pritchard added a 10,000 KW turbo-generator.



A 5,000 KW turbo-generator installed for a southwestern utility.



A 7,500 KW turbo-generator added to a western plant.

Consult PRITCHARD

Pritchard's extensive experience with plant expansion work assures prompt and economical design, engineering and installation for your own project.

**Examples of such installations that were developed in their entirety by J. F. Pritchard & Co., are shown above and at the left.*

Expressly devoted to corporate utilities and industrial users of electric power and steam, the services of the Power Division of J. F. Pritchard & Co. are available to you immediately. If you are planning either complete new stations, additions or alterations that must produce power at a profit, consult Pritchard NOW!

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Too tight in winter?

Deep sags in summer?

Both are costly, unnecessary hazards. Correct tensioning of your overhead conductors, with Dillon Dynamometers, will prevent outages from sleet and wind in winter, and assure safe and proper sags in the heat of summer.

TO HELP you get full life service from your conductors, wire manufacturers have spent thousands of dollars determining the exact tension at various temperatures and spans for pre-stretching and installation of their wire. Abiding by their recommendations will lengthen conductor life, and minimize outages when sleet and ice come.

Dillon DYNAMOMETER

Dillon Dynamometers are designed specifically for this purpose. They are light, compact, easy to use and accurate.

TO GET YOUR *free* COPY

of the "Rules of Successful Wire Pre-Stretching and Stringing," written by experienced linemen, drop us a note today.

W. C. Dillon & Co., Inc.

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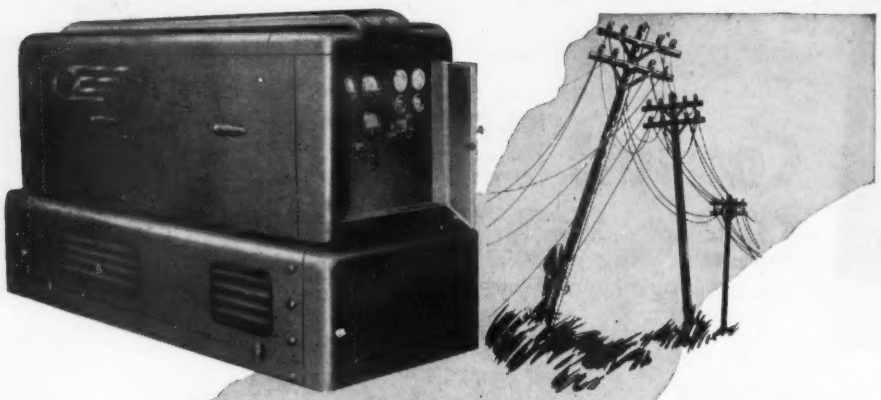

Guard Against Costly Power Failures with

ONAN STANDBY ELECTRIC PLANTS

When power fails, business comes to a standstill. Materials in process are wasted, men and machines stand idle, lives may be endangered. Prevent the disastrous effects of power failure with a low-cost, easy-to-install Onan Standby System. The generating plant starts automatically when commercial power fails, takes over the power load without interruption, stops automatically when power is restored. Many models: 350 to 35,000 watts, A.C.

D. W. ONAN & SONS INC.

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Onan PRODUCTS

ONAN STANDBY POWER

RECENT RATE CHANGES

CENTRAL VERMONT PUBLIC SERVICE CORP. has applied to the Vermont and New Hampshire commissions for rate increases aggregating about $317,000 per year. Additional net revenue is estimated at $200,000. Simplified tariffs have been a major objective. Only four rates of general application are proposed. These are: one residence service rate, for household and farm customers; one off-peak water heating rate; one general service (or commercial) rate; and one wholesale power rate (for large volume customers). In the new general service rate a fuel adjustment is provided on consumptions above 5,000 kwhr per month. Water heating will carry a fuel clause. The new rate requested is 20 kwhr for $1.50 against 14 for $1 before. The next 25 will cost 5 cents each instead of the next 40; The next 55 will cost 3 cents each instead of the next 66. All over 100 will cost 2.5 cents each instead of 2 cents for over 120.

ATLANTIC CITY ELECTRIC CO has sought an increase of $195,000 a year in electric rates. Bayard L. England, company general manager, at a hearing told John Boswell, president of the New Jersey Board of Public Utility Commissioners, that profits were declining despite higher gross income.

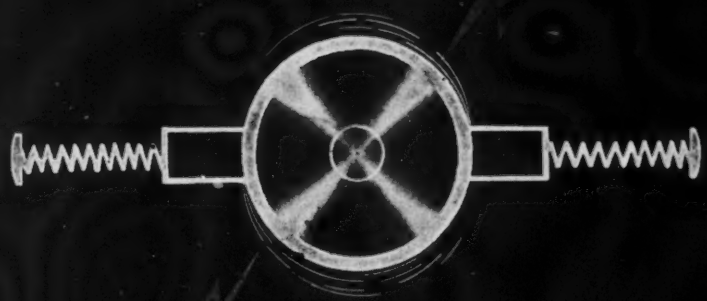
GEORGIA POWER & LIGHT CO's electric rate increase, granted recently by the state Public Service Commission (*EW* June 5, p 218), has brought a storm of protests from REA cooperatives, municipalities and industrial users. REA coops have threatened to build their own generating plants unless they are relieved of the higher rates, which were granted to cover higher fuel costs. Valente Bennett, president of the Georgia Electric Membership Corporation, has appointed a committee to include himself. Walter Harrison of Millen; James B. Polhill, of Louisville, and T. S. Mason of Hartwell, to survey the need, costs and location of from one to three generating plants to use fuel oil or natural gas. Since Georgia Power & Light purchases power from Florida Power Corp, parent company, further investigation by the commission and the Federal Power Commission must be made before changes can be made in the temporary higher rates.

•

Opens Office in Monterrey

The Mexican subsidiary of the Minneapolis-Honeywell Regulator Co has opened a branch office at Monterrey. William H. Westphal, manager of the company's international division, has announced. Honeywell-Brown S. A., Mexico, D. F., was incorporated a year ago with headquarters in Mexico City. The Monterrey office is the first branch to be opened by the subsidiary. Francisco B. Rocha has been placed in charge of the Monterrey branch. Address of the new office is Pino Suarez 486 Sur on the main Laredo-Mexico City highway. The territory covered by the branch includes the states of Nuevo Leon, Tamaulipas, Coahuila, Durango, Zacatecas, San Luis Potosi and Chihuahua.

THE NATION'S LEADING PRODUCER OF SMALL MOTOR BRUSHES



Stackpole's Minute Man — your assurance of highest molded materials quality.

Recent Stackpole developments have been signally successful in bettering fractional horsepower motor brush performance—even when no trouble existed and where the only problem was the ever-present one of making sure you get the best brushes for your money.

We prefer to make brush recommendations on the basis of tests of the actual equipment under simulated working conditions in the Stackpole Brush Testing Laboratories. Experience has proved we can serve brush users best by this scientific approach to a matter all too often handled by rule-of-thumb methods. Why not let us check your brushes on this basis—with the responsibility being Stackpole's to PROVE that better brushes can be obtained?

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

STACKPOLE

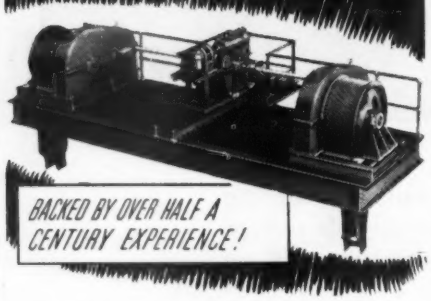
BRUSHES and CONTACTS (All carbon, graphite, molded metal and composition types)—RARE METAL CONTACTS • SINTERED ALNICO II WELDING CARBONS • CHEMICAL CARBONS • CARBON SPECIALTIES

PACKING, PISTON and SEAL RINGS • CONTINUOUSLY ADJUSTABLE CARBON RHEOSTATS • SPECTROGRAPHITE NO. 1, etc., etc.

BLAW-KNOX
TRANSMISSION TOWERS

BLAW-KNOX DIVISION
of Blaw-Knox Company
2013 Farmers Bank Building
Pittsburgh, Pa.

WHEN YOU PLAN
POWER DAM PROJECTS
ASK US ABOUT
GATES & GATE HOISTS



Murray Gate Hoists are designed and built to meet all requirements . . . from the smallest hand operated to large motor operated—a wide range of capacities from less than 1 ton to over 100 tons. During our nearly half a century of designing and building gate hoists we have developed various designs for the different types of gate hoist problems. We feel sure we have designs and patterns that will fit your requirements.

We also build gate hoists entirely from your plans and specifications, if desired. In planning gates or gate hoists it is suggested you communicate with us before your plans for the project as a whole are completed . . . it will save expense and much preparation time.

Our engineering department is at your service any time to help solve problems involving this type of equipment.

MURCO
D. J. MURRAY MANUFACTURING CO.
WAUSAU WISCONSIN

NEW ELECTRICAL CONSTRUCTION

A weekly selection of U. S. electrical construction projects announced by private and government utility systems involving more than $70,000. Also listed are major industrial and construction jobs where electrical work is indicated or implied

UTILITIES

Proposed Construction

Florida—Suwanee Valley Electric Co-operative Inc., Live Oak., 240 mi. rural d.str. lines. sys. imprvs., 4 mi. tie lines, Lafayette Co. **$490,000.**

Idaho and Oregon—Bureau Reclamation, Interior Bldg. 19 and C Sts., Wash. 25, D. C., plans Hells Canyon Dam and Reservoir, in Sanke River Canyon. **$433,-600,000.** Report sent to Columbia River Basin States.

Illinois—Illinois Power Co., 135 N. Main St., Decatur, 58 mi. power transmission lines between Belleville and Ashley. **$900,-000.**

Ia., Denison—City, R. L. Rule, clk., municipal power bldg. program, incl. 3,000 kw. turbo-generator, generating unit, boiler feed pumps, feed water heater, piping, etc. Approx. **$500,000.** Lutz & May, 819 Finance Bldg., 1009 Baltimore Ave., Kansas City, Mo., consult. engrs.

Missouri—Scott-New Madrid Mississippi Co-operative Assn., Sikeston, 250 mi. rural distr. lines, imprv. existing lines Mississippi, New Madrid and Scott Counties, etc. **$850,000.** Rural Line Engineers, 2 S. Central Ave., Clayton, St. Louis, Zone 5, engrs.

Missouri — Pemiscot-Dunklin Electric Co-operative, Hayti, rural distr. lines, imprvs., exten. facilities, Pemiscot and Dunkin Counties. **$1,000,000.** Rural Line Engineers, 2 S. Central Ave., Clayton, St. Louis Zone 5, engrs.

Oklahoma — Northfork Electric Co-operative, Sayre, 353 mi. rural distr. line, sys. imprvs. 60 mi. new tie line, Beckham Co. **$790,000.**

Oregon—Douglas Electric Co-operative, Roseberg, 72 mi. rural distr. line, 8 mi. transmission line, sys. imprvs., 2 mi. heavy-duty tie line and completing previously approved construction, Douglas Co. **$565,000.**

South Carolina — Marion Electric Co-operative, Marion, 222 mi. rural distr. line and sys. imprvs., Marion Co. **$400,000.**

Tex., Houston—United Building Supply Co., c/o Murel Goodell, genl. mgr., 3127 Calhoun St., 140 story, full bsmnt., steel, masonry commercial bldg., incl. steam heating, air-conditioning electric light plant and sys. **$25,000,000.**

Virginia and North Carolina — U. S. Eng., Fort Norfolk, Norfolk 1, Va., two 1,600 hp. hydraulic turbines and governors, Buggs Island Reservoir Proj., Roanoke River, Inv. Eng-44-110-48-279.

Wisconsin—Dairyland Power Co-operative, La Crosse, purchasing, installing of 15,000 kw steam turbine unit, purchase and install 5,000 kw hydro-generating unit, 73 mi. rural distr. line, rehabilitation of hydro-generating unit and purchasing of Josie Island dam site, LaCrosse Co. **$3,315,000.**

Wis., Marshfield—City, Water & Light Comn., E. F. Kipp, secy., furnishing, installing in power plant, steam turbine-generator, surface condenser and auxiliaries. Over $68,000. Plans deposit $20. Helmick, Edeskuty & Lutz, 405 Essex Bldg., Minneapolis, engrs.

Wyoming — Bureau Reclamation, Dpt. Interior, Building 1-A, Denver Federal Center, Denver, Colo., furnishing, del. f.o.b. cars shipping point or f.o.b. cars Bonneville, 4 air compressors, rotary high speed, air-cooled, sliding multivane type; direct connected to electric motors through flexible couplings and mounted on rigid bases at integral units, each compressor to be furnished with suction air cleaner, silencer, automatic air unloading valve and automatic oil supply, four outlet works at Boysen Dam, Boysen Unit, Spec. 2294. Plans deposit $1.

Low Bidders & Contracts Awarded

Alabama—Joe Wheeler Electric Membership Co-operative, Hartselle, 210.29 mi. rural distr. lines. Morgan Co., etc., from Birmingham Building Co., 315 S. 20 St., Birmingham. **$264,586.**

Mich., Iron Mountain—Wisconsin-Michigan Power Co., 137 W. Mill St., Appleton, Wis., power plant and dam, south of here, Big Quinenesec Falls on Menominee River, to C. R. Meyers & Sons Co., 50 State St., Oshkosh, Wis. Est. **$2,000,000.**

O., Cleveland — Lincoln Electric Co., James F. Lincoln, 12818 Coit Rd., design and construction, masonry, aluminum and steel electrical plant, St. Clair Ave. and E. 178 St., to The Austin Co., 16102 Euclid St. Approx. **$10,000,000.**

Tennessee—Southwest Tennessee Electric Membership Corp., Brownsville, 144 mi. rural distr. line, Madison Co., to Whalley Constr. Co., 318 E. Orleans St., Jackson. **$230,683.** Pat M. Sullivan, 905 Stahlman Bld., Nashville, Zone 3, engr.

INDUSTRIALS, COMMERCIAL & PUBLIC BUILDINGS

Proposed Construction

Calif., Los Angeles—Bd. Regents University of Calif., 405 Hilgard Ave., plans by Allison & Rible, 650 S. Grand Ave., 3 story, rein.-con., brick, 85x220 ft. Engineering Bldg., incl. classrooms, laboratories. **$1,250,000.** F. N. Ropp, 727 W. 7 St., consult. engr.

Calif., Tulare—Tulare Hospital Distr. plans by H. C. Chambers, 124 W. 4 St., Los Angeles, 60-70 bed concrete type 1, 2 story, bsmnt. hospital, **$1,000,000.** W. D. Coffey, 649 S. Olive St., Los Angeles, consult. engr.

Ga., Macon—Glidden Co., Berea and Madison Sts., Cleveland, O., food products plant. **$2,500,000.**

Ill., Normal—State, Springfield, Special Education Bldg., at Illinois State Normal University, $1,800,000. Lundeen, Hilfinger, Schaeffer, Hooton & Wilson, 220 W. Jefferson St., Bloomington, assoc. archts. and engrs. Administration Bldg. at Illinois State Normal University, $580,000. C. Herrick Hammond, Springfield, state archt.

N. Y., Brooklyn—New York City Housing Auth., 122 E. 42 St., New York, Zone 17, plans by Fellheimer, Wagner & Vollmer, 155 E. 42 St., New York, Zone 17. Albany Houses NYS-40, housing for 828 families on site bounded by Park Pl, Albany, St. Marks and Troy Aves. **$8,000,000.**

Tex., McCamey—Slick Oil Co. and Associated Companies (Urschel Co. and Plymouth Co.), Milam Bldg., San Antonio, recycling plant. **$4,000,000.**

Va., Staunton—Kings Daughter Hospital, Box 598, 117 bed hospital. $1,750,000. York & Sawyer, 101 Park Ave., New York 17, N. Y. archts. Edwards & Hjorth, 1267 6 Ave., New York, N. Y., engrs.

Low Bidders & Contracts Awarded

N. H., Manchester—U. S. Eng., 31 St. James St., Boston, June 22, bldgs., utilities for Veterans Admin. Hospital, Serial No. W-19-016-eng-48-55, from George A. Fuller Co., 11 Beacon St., Boston, Mass., **$3,580,000;** elevators, from Warsaw Elevator Co., Warsaw, N. Y., **$97,837.**

N. M., Albuquerque—U. S. Eng., Commercial Bldg., 152 frame, stucco housing units, utilities, incl. gas, water, sewer and electric distr. and street lighting, etc. Sandia Base, Serial No. W-29-005-eng-48-27, to Haddock Engineers, Ltd., Box 429, Oceanside, Calif., Lot I. **$1,545,997.** Bids 1/19.

N. M., Los Alamos—U. S. Atomic Energy Comn., P. O. Box 1539, steam generating plant, Group 10, Scope B, police barracks, Scope A, Inv. 291-48-73, to Robert E. McKee, El Paso, Tex. **$1,038,-578.** Bids 6/15.

Tex., Stiles (Big Lake P. O. or c/o R.F.D.)—Witco Hydrocarbon Corp., Commerce Bldg., Houston, carbon black plant, to Panhandle Carbon Co., c/o owner. Approx. **$1,000,000;** 100,000 gal. natural gasoline plant to Fish Eng. Co., M & M Bldg., Houston. Approx. **$2,500,000.**

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DAYTON 2, 1315 Mutual Home Building
DETROIT 2, 15 Lawrence Avenue

REPRESENTATIVES in MINNEAPOLIS 3, 1208 Harmon Pl., and PEORIA 5, 101 Heinz Court

CATALOGS • BULLETINS

● LIGHTING: Bulletin 20-B describes a line of aluminum parabolic recessed troffer fixtures for two 40-W fluorescent lamps. Bulletin 30-D covers a line of inspection fixtures and accessories. Bulletin 30-E lists data for a new 240-T industrial unit for two 40-W fluorescent lamps. Day-Brite Lighting Inc, 5411 Bulwer Ave, St. Louis 7, Mo.

● INSULATION: Data on commercially available types of silicone rubber are given in "Salastic Facts No. 5," a 16-page book. Dow Corning Corp, Midland, Mich.

● SUBSTATIONS: Multi-circuit unit substations with oil-filled, Chlorextrol liquid-filled, and dry type transformers have construction high-lights in Bulletin 11B6935. Allis-Chalmers Mfg Co, Milwaukee 1, Wis.

● LEVEL CONTROLS: Floatless liquid level controls consisting of induction relay and electrodes are outlined in a 4-page leaflet. B/W Controller Corp, Birmingham, Mich.

● MOTOR STARTER: Publication 192 explains how the high-interrupting-capacity fuses provide short circuit protection included in starters for high-voltage induction and synchronous motors. Electric Machinery Mfg Co, Minneapolis 13, Minn.

● GLOVES: Linemen's gloves, bags, belts and safety straps are listed with construction, description and specifications in a 4-page leaflet. Industrial Products Co. 2820 North Fourth St, Philadelphia 33, Pa.

● PROTECTIVE COATING: A 4-page leaflet provides characteristics, properties, performance, and application of Zincilate, a one-coat, self-protecting, anti-corrosion coating for towers, railings, pipe lines and truck parts. Industrial Metal Protectives, Inc, 137 North Perry St, Dayton 2, Ohio.

● MOTOR CONTROLS: Catalog 48 gives ratings, descriptions and dimensional data on drum controllers, magnetic reversing switches, also foot, overload, limit and hoist switches. Furnas Electric Co, Batavia, Ill.

● BEACON: Bulletin 47042 has a beam-distribution chart to explain the effects of application of the Bartow type 36-in. spherical rotating beacon for airports. Line Material Co, East Stroudsburg, Pa.

● LIGHTING: Booklet "The Right Ways to Light Your Merchandise" has been completed as a guide to demonstrate lighting which focuses maximum attention on the merchandise. Sylvania Electric Products, Inc, 211 Derby St, Salem, Mass.

● ELECTRICAL FARMERS: Suggestions for the electric power supplier interested in promoting Better Methods Electric Program among 4-H club members are contained in a 20-page booklet "Electrical Farmers for Tomorrow." Westinghouse Electric Corp, Box 1017, Pittsburgh 30, Pa.

● COAL CLEANING: Information on four coal cleaning systems with explanatory circuits, illustrations of machines, and diagrams of operation are provided in Bulletin 216. McNally Pittsburgh Mfg Corp, Pittsburgh, Kansas.

● INVENTORY CONTROL: "How to Get Profits from Inventories" is a 24-page booklet illustrating and describing methods of simplifying the management of stock. Systems and Methods Research Dept, Remington Rand, Inc, 315 Fourth Av, New York 10, N. Y.

● ANCHORS: Two-piece, all-steel expansion anchors in holding-power classes 4,000 to 12,000 lb have specifications, description and installation illustrations produced on a 2-page leaflet. Pieper-Lillard, Inc, 729 Paul Brown Bldg, St. Louis 1, Mo.

● VALVES: Catalog 12-G6 gives construction, design data and specifications of forged steel chrome-molybdenum Intex valves (bolted bonnet integral seat) rated at 1500 lb, 1000 F, and Univalves (welded bonnet integral seat) for service at 1500 and 2500 lb, 1000 F. Edward Valves Inc, East Chicago, Indiana.

● FIRE-SAFETY: Each of twelve pages of a 16-page booklet deals with a separate feature. Construction standards, automatic sprinklers, water supplies, extinguishers, watch service and fire-fighting organizations are included. Associated Factory Mutual Fire Insurance Companies, Inspection Dept, 184 High St, Boston 10, Mass.

● TRANSFORMERS: Bulletin 61B-6152A explains how an a-c network system operates, also describes construction, operation and application of network transformers 300 to 1,000 kva. Allis-Chalmers Mfg. Co, Milwaukee 1, Wis.

● SWITCHGEAR: Development of standard units of truck type circuit breakers; assembly, testing and outlines of Multiple switchgear are presented in Cat. 7000. I-T-E Circuit Breaker Co, 19th and Hamilton Sts, Philadelphia 30, Pa.

● BRAKE: Six-page folder describes and illustrates type M magnetic brake for mill type d-c motors. Cutler-Hammer, Inc, 235 North 12th St, Milwaukee 1, Wis.

● RELAYS: Motor-driven type, time delay relays for a-c operation are listed with connections, description and specifications in Bulletin 362. Ward Leonard Electric Co, 31 South St, Mt. Vernon, N. Y.

● LIGHTING: Pamphlet contains suggestions and list of fixtures for indirect design by combined unit consisting of silvered bowl lamps and Sight Savers, light reflecting media, in adaptor or suspension types. Silvray Lighting, Inc, R. K. O. Building, Radio City, New York 20, N. Y.

● FIRE EXTINGUISHERS: Charts showing characteristics of hand fire extinguishers, comparative effectiveness of approved extinguishers on flammable liquid fires, also listing of company's dry chemical type extinguishers, are contained in a 16-page catalog. Ansul Chemical Co, Marinette, Wis.

● CONTACTS: In addition, a line of capacitors, rectifiers, resistors, switches, vibrators, welding tips and holders, special metals and alloys, and metallurgical products are listed in Catalog No. 1. P. R. Mallory & Co, Inc, 3029 E. Washington St, Indianapolis 6, Ind.

Cole Electric Co.

8439 Steller Drive — Culver City, Calif.

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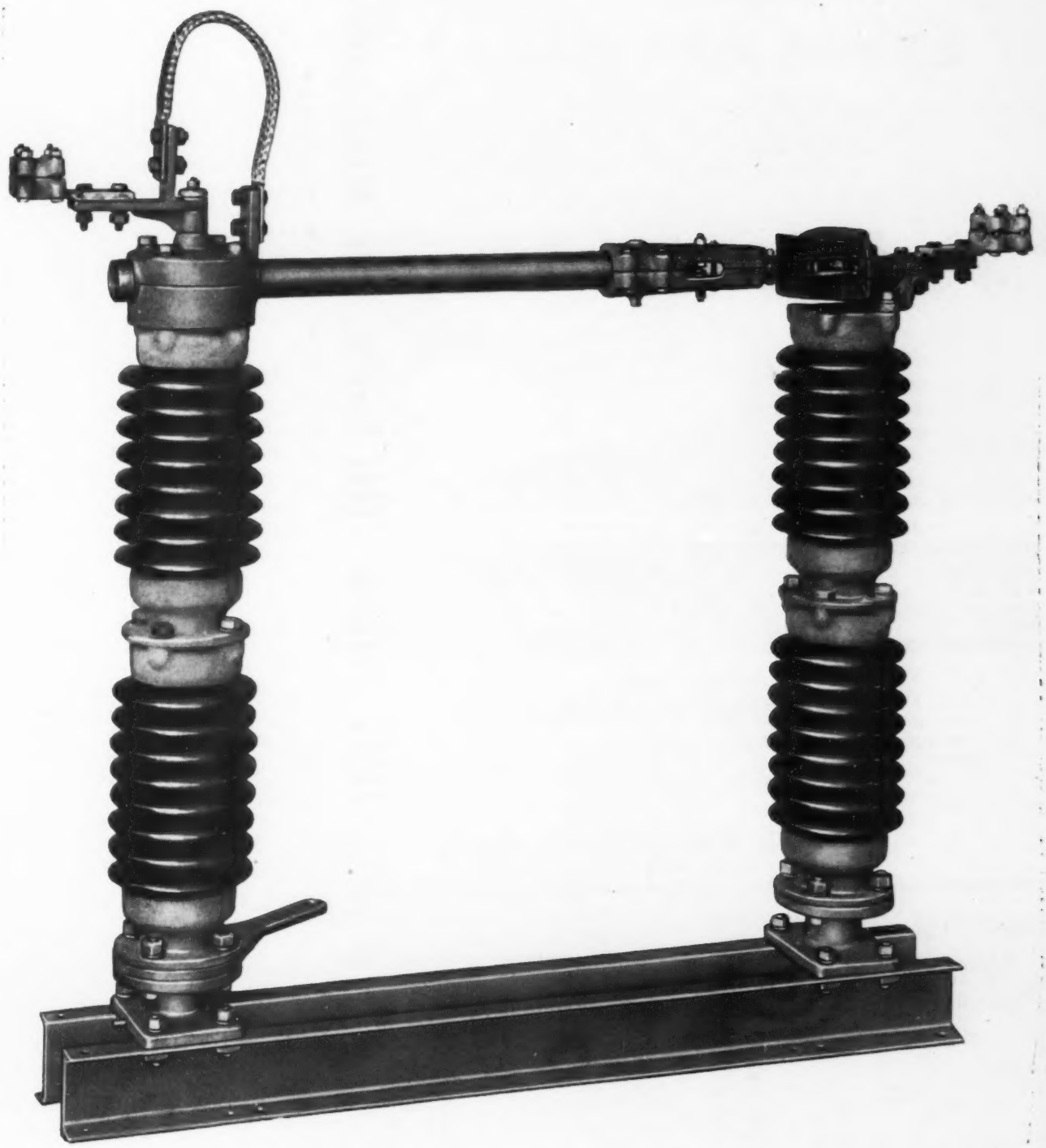

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For upright, vertical or underhung mounting

(See Bulletin 42-A)

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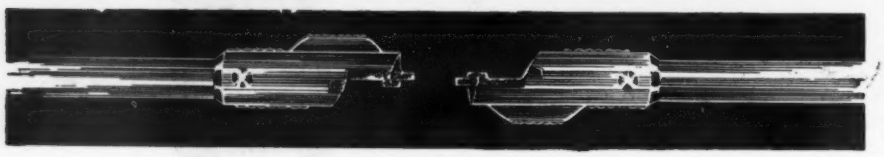

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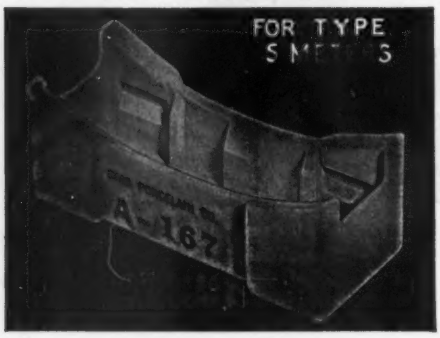

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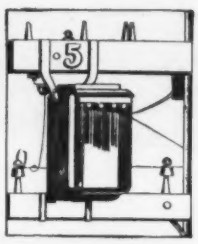

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LETTERS TO THE EDITOR

To the Editor of ELECTRICAL WORLD:

Your editorial item, "By-Product of Load Research", in the issue of May 22, P 92, challenges the writer to retort that "it can't happen here", but on further thought a far more important fact is brought out. Could it be possible that the lack of knowledge concerning customers and their use of electricity is due in large measure to the lack of neighborly contact with customers?

Are we just selling kilowatt-hours, or are we supplying electric service? Is the former good policy for the utility, since often it allows the customer-company relationship to deteriorate?

In our city of 600,000 customers, we have centralized operation. We've been studying this matter of customer contacts. From what we have learned, we are planning to try a decentralized operation. We want to regain the small-town intimacy with utility service men and other employees, the speaking acquaintance and the neighborliness with customers that is frequently lost in the growth of a big business.

Most of our customer contact people —meter installers, servicemen, customer representatives, home advisors, lighting salesmen, etc.—cover the entire city area. This means that they have little opportunity to become well acquainted with customers. They see them only in rendering the specific service wanted at time of call.

We also have many branch offices throughout the city. It is our thought that by decentralizing most of the operating staff into these branch offices, employees who call on customers will become better acquainted with them and improved customer relations will result.

We also operate in many small towns outside of the metropolitan area. We believe there is a neighborliness and close acquaintanceship with our employees in those towns that creates very good public relations. It is this feature that we feel is lacking in a large city operation and that can be gained only through decentralization of all activities.

This is not a new idea but is simply the "district representative" plan applied to a larger operation.

R. T. Duncan,
Commercial Manager
The Detroit Edison Co.

To the Editor of ELECTRICAL WORLD:

I want to compliment you upon your fine editorial, Sauce for the Ratepayer, which appeared in your January 3, 1948 issue.

However, I am not sure I agree with